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INTRODUCTION

The sulphur and sulphuric acid industries in Soviet Russia are in a confused and disordered condition. Conflicting opinions, statements and plans pour in on the observer from all sides. On one hand, the Non-Ferrous Metal Trust (Glavzvetmet) is making plans and experimenting on the utilization of the pyritic tailings. On the other hand, the Chemical Trust is pushing a huge program to exploit the native sulphur deposits and to utilize the pyrite obtained from coal.

In an attempt to obtain information in Moscow concerning these plans, one is confronted by strict silence on the part of the Chemical Trust, which has been recently required to conduct its sulphur operations as military business of secret status. On the other hand, the Non-Ferrous Metal Trust regards its sulphur as secondary to copper production and views with suspicious surprise, interest in this secondary angle of its operations. To further confuse the picture this industry has not yet come under strong central planning at Moscow to the extent that prevails in Soviet industry in general. Its resources are so scattered and remote that field engineers at each district are still largely making the plans, gradually

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preparing for full centralized control. It has been necessary in view of this general embargo on information to weld together data secured in devious ways.

The complete picture has been built up by private conferences with Soviet Engineers and Directors known to be reliable; personal visits to several of the mining regions by my two assistants and myself (in some cases considerable periods of former work and inspections in these regions); discussion of conditions and reserves in the sulphur and pyrite fields with engineers somewhat removed from same but possessing ways of securing current information on them; and the selection, removal from the country, and translation on this side of technical journals and books (~~more than a hundred~~ in number) carrying authoritative material by known engineers.

The chaotic condition in the Soviet sulphur industries started several years back. Up to the Spring of 1931, good feeling existed between the Non-Ferrous Metal Trust and the Chemical Trust, the former supplying the pyritic material and the latter converting it into sulphuric acid. Plans for new smelters, flotation plants, sites, etc. were formed at this time for the Non-Ferrous Metal Trust, one of which major plans submitted by an American engineer and endorsed and furthered by the writer contemplated the erection of a great central chemical and metallurgical combine at Samara (at the

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center of European Russia) for treatment of the bulk of the Ural pyritic ores and many other raw materials of the Volga basin. This plan was eventually turned down for various reasons.

The Chemical Trust, desirous itself of establishing a chemical center at Samara, heard of this plan and promptly brought it to the attention of the Supreme Economic Council in an effort to force the reluctant Metal Trust to adopt it. After weeks of meetings, arguments and debates in the Soviet press, the Supreme Economic Council came to a decision against the new industrial center at Samara, upholding the Non-Ferrous Metal Trust in carrying on at its existing and projected Ural plants. From that decision on, the Chemical Trust started a program to exploit its native sulphur deposits and to utilize the coal pyrites in the South which up to that time had received little or no attention. This "war" was further aggravated by the Non-Ferrous Metal Trust shipping poor grades of pyrite tailings to the Chemical Trust's acid plants.

In 1934, the Non-Ferrous Metal Trust, faced with the realization of the progress and plans made by the Chemical Trust with the native sulphur deposits and coal pyrites, began to pay more attention to the pyritic tailings of the Urals. Mills were re-designed for re-flotation of the tailings to increase sulphur content (35/42% up to 47/48%); driers began to come into use for reducing the water content

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of the tailings; and large sums were set aside for the purpose of field experiments on a semi-commercial scale for the extraction of elementary sulphur from the tailings. Three such plants are in operation at the present time and produce the bulk of sulphur in Russia, while a fourth, which utilizes the free atom of sulphur, is making numerous experiments.

The "war" still continues, and Trust uses the medium of the press to boost its own efforts and to enhance its own importance. Numerous articles have appeared and are appearing which on personal observation in the field have proved to be on the optimistic side. There is a possibility in this industrial mix-up that production plans will mature that are not economically sound and that the Soviets may find themselves a few years hence with an excess of sulphur and sulphuric acid. (It would assure that said plans will be attended with greater processing success than has yet appeared.)

With elementary sulphur coming at present from two sources, viz., native deposits and polymetallic pyrite deposits, and threatened from coal pyrites, it has been necessary not only to discuss many plans with local engineers but to make detailed studies of each district in order to determine the feasibility of each plan. We are dealing not with a single source of raw material but with a nation's resource,-with hundreds of scattered deposits and operations in a country that occupies approximately one half

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of Europe and one third of Asia. Conclusions as to the utilization of these resources must, moreover, be viewed from the peculiar economy of a Soviet regime.

In the following report special emphasis has been placed on mining operations as this mining angle, in the majority of cases in Soviet Russia, will be the limiting factor in sulphuric acid and sulphur production. Metallurgical plants of any capacity can be built but unless ore is available, they are of little use except as monuments to Soviet enthusiasm.

Plans under Soviet conditions are apt to be changed, and the purpose of this report has been to cover the essentials that will serve as a basis upon which future changes in these sulphur and acid plans may be gauged as to commercial importance.

The report has been divided into five sections.

I Native Sulphur

II Pyrites

III Miscellaneous Sulphur Sources

IV Economic Factors

V Summary

VI Bibliography

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I

NATIVE SULPHUR SECTION

"Soviet Russian Sulphur"

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MIDDLE VOLGA REGION

SAMARA DEPOSITS

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SAMARA DISTRICT

LOCATION

This district is located to the north and north east of the city of Samara, an approximate thirty hour ride by train from Moscow. This is the Middle Volga country in the heart of European Russia. (See sketch.)

HISTORY

Sulphur in this district has been known since the time of Boris Gudonov. During the reign of Peter, the First (early eighteenth century) some sulphur was mined in the Sergievski deposit, 120 kilometers east of Samara. In 1720 production was stopped at that place and operations transferred to the vicinity of the village of Podgori on the right bank of the Volga river. At the end of the eighteenth century all production was stopped until 1916, when attempts were made to mine sulphur during the war period. From that time, these deposits remained idle until 1931 when the Soviet Government again directed attention to them.

GEOLOGY

Travelling upstream from Samara, viewed from the river steamer, the whole Middle Volga country on both banks, extending to the very tops of the hills that line the stream, is solid white gypsum and alabaster, the white beds

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extending clear to the surface immediately under the thin coating of dark humus soil. Scores of lime and gypsum plants (approximately one every half mile) line the waters' edge. After an eight hour river journey north, the gypsum takes on a darker color, with sandstone and limestone association.

The sulphur in this district is found in thin horizontal beds associated with bituminous dolomites and limestones in the lower portion of the Upper Pliocene series, which in itself forms the upper part of a formation locally called the "Kazanski." This Kazanski formation is represented by beds of dolomite, bituminous limestone, gypsum and anhydrite, the latter always being found in the lower portions. Above the anhydrite are alterations of marls, gypsum and dolomite. The gypsum does not lie in thick beds but occurs largely as impregnations or as narrow lenses. The bituminous limestones are found in close proximity to the sulphur beds.

DEPOSITS

Alexievski - The prospected portion of this deposit is located in the vicinity of Prigorod, a village on the Moscow-Samara-Cheliabinsk-Tashkent railroad line. The deposit, thus far, is limited on the south by the river Samaraka and on the north by the Suhia Podvoka Valley. The prospecting work includes the drilling of 97 holes (total length 6,605 meters); prospect shafts (total

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length 867 meters) and 200 meters of underground cross-cuts.

The first sulphur horizon, lying at a depth of from 6 to 18 meters below the surface, varies in thickness from a few inches to 7½ feet, with an average thickness of 3 feet. The average sulphur content of t is horizon, from analyses of the above drill holes and prospecting shafts, is 9.68 per cent. The second sulphur horizon, lying 5 meters below the upper and separated from it by a bed of bituminous limestone, varies in thickness from a few inches to 3 feet, with an average thickness of one foot.

The sulphur in both horizons, sometimes in a pure state but, generally, associated with or coating calcite, is found filling cavities or cracks.

Vodina deposit is located near the village of Vodina, Krasnoiarski district, 27 kilometers northeast of Samara or 12 kilometers north of station Smishliaevka on the Moscow-Samara-Tashkent-Cheliabinsk railroad. This deposit discovered in 1933 has been explored by a geological survey over an area of 6 square kilometers (600 hectares). Drill holes and prospect shafts up to 75 meters in depth have proved an area of only 8 hectares. (Drill holes average 40 meters and prospect shafts 19 meters.)

Prospect shafts No.4, 7 and 15 passed through three sulphur horizons of total width 7 meters. Other holes passed through 2 to 4 sulphur horizons varying in

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thickness from 0.7 to 2.5 meters. The analyses of 11 drill holes and 12 prospect shafts show that the minimum sulphur content is 5.24 per cent and the maximum is 26.45 per cent. The average is nearly 15 per cent.

The two upper sulphur horizons at Vodina, separated from each other by bituminous limestone and containing the bulk of the sulphur reserves, are found 7 to 35 meters below the surface. The two lower sulphur horizons of narrower thicknesses are lying 10 meters or more below the upper horizons. In some portions only two horizons are found. All horizons are of narrow, irregular thickness.

The sulphur in all horizons is found filling the cavities or cracks in a purer state than found in the Alexievski deposit.

Barbashanski Poliana deposit is located 13 kilometers north of Samara. A few drill holes put down here cut two sulphur beds of total width 2 meters. The sulphur content is said to vary from 12 to 40 per cent. The sulphur occurs here in a similar manner to that in the Vodina and Alexievski deposits, that is, it is irregular in sulphur content and in thickness. As the drill holes were put down on kilometer intervals, they have only proved the presence of sulphur rather than its thickness and grade. Undoubtedly the grade will be the same as that found at the better known deposits.

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Sireika Village: Exploratory work at this village, 7 kilometers north of Alexievski, has proved that sulphur is present.

Krasnia Glinka: Exploratory work at this place, which is near the junction of the Volga and Oka rivers or about 20 kilometers north of Samara, has discovered a small sulphur bed.

"Sulphur Mountain, which is located across the Volga from Krasnia Glinka was worked for its sulphur in the times of Peter the Great. Now abandoned.

Village of Novoboshina: Near this village, which lies between Vodina and Krasnia Glinka, has been found a gypsum bed containing small amounts of sulphur.

Six to eight kilometers northeast of Samara are found springs which give off a strong odor of sulphur. As these are along the Chernovski road, exploratory work here is expected to find commercial sulphur.

Altogether, in the region east and northeast of Samara (now renamed "Kuibyshev") and within 30 kilometers of the city, there are eleven known occurences more or less similar to Alexiev and Vodina. Prospecting (drilling and excavation) is going on (1935) between these eleven points to determine continuity and characteristics of the entire district.

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MINING

Alexievski Deposit At the present time some tonnage is produced through two small shafts, 28 and 38 meters in depth. This underground work is, however, only temporary and will be replaced by large scale open pit methods. The application of an open pit method for this deposit warrants considerable thought due to the excessive amount of overburden to remove. The two sulphur horizons separated by 5 meters of bituminous limestone, lie at a depth from 6 to 18 meters from the surface. The relation of the waste to be removed and the amount of sulphur ore mined will be as follows:

6 to 18 meters	(overburden on upper sulphur horizon)
5 to 5 meters	(bituminous limestone layer on lower horizon)
11 to 23 meters	total overburden

The thickness of the upper sulphur zone is		1.3	meters
" " " " lower	" " "	0.35	"
	Total	1.65	" of sulphur ore

Therefore the ratio of waste to be removed to ore varies from 7 to 1 to as high as 14 to 1.

This compared with open pit methods in other countries is an excessive ratio and undoubtedly this method will prove very expensive in the Alexievski deposit. In addition, winter conditions are always severe and will

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seriously affect production and tend to raise the costs as a large amount of water is present. As the sulphur bearing horizons appear to be wide spread, the disposal of the large amount of overburden will present a serious problem as this waste must be transported quite a distance.

At best, the grade of sulphur is low, but with an open pit method (with which it is impossible to mine these horizons cleanly) the grade of ore to the mill will be still further lowered. Higher milling costs than anticipated will result.

The introduction of an underground mining system would offer many problems. The development costs would be high; timber, scarce in the vicinity, necessary; pumping costs high; and sorting and waste disposal underground costly and slow.

Either mining system will prove expensive but of the two, the underground method will prove the cheaper and give the cleaner ore, but the daily tonnage could not be large.

At the Vodina deposit, an open pit method is to be introduced for the mining of the two upper sulphur horizons and an underground mining method for the two narrow lower sulphur horizons. The same comments as to mining method, given above, apply to this deposit.

ANHYDRITE

The present Soviet Government, in its plans to

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utilize all waste materials regardless of cost, has directed attention to the anhydrite beds which have a thickness of from 10 to 12 meters and are lying some 70 meters below the surface. The reserves of these beds are estimated (by Soviet engineers) at several hundred millions tons or sufficient to supply 1,000,000 tons of sulphuric acid annually for 100 years. Laboratory tests, following the method which the Germans used during the war, have led the Soviets to believe that a ton of sulphuric acid can be extracted from the anhydrite at a cost of 34 roubles 75 kopecks (not including mining costs). Prof. Norkin, Head of the Ore Dressing Department at Leningrad University, in a conversation with me said that no serious attempts to use the anhydrite will be made for some years to come, and that the work is purely experimental.

SAMARA

The low grade sulphur ores at Samara (head assays near 5% due to dilution by open pit method) will be sorted first, and the hand picked sulphur ore sent to the autoclaves directly. The remaining ore will be crushed to 50 or 58 per cent mesh and sent to a flotation mill for concentration. If $CaSO_4$ is present as the main gangue mineral, the ore will be crushed to 150 mesh, as the $CaSO_4$ tends to float into the sulphur concentrates. Pine oil and kerosene are the flotation reagents used; the flotation is an easy one, giving a

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high grade, 70% concentrate. The concentrates and high grade sorted ore will be autoclaved by the Volkov autoclave now in operation at Shor-Su, Crimea and Kara-Tun, and which will be installed at Gaurdak, also. One per cent tannic acid is added to the moistened concentrate in the autoclaves which operate at a temperature of 15[illegible] degs. . and a pressure of about 6 atmospheres.

The sulphur from the autoclaves, containing from 1.5 to 2 per cent bitumins, must be further refined. Two methods have been proposed and tried - one by addition of 1 per cent of H_2SO_4 and silica gel absorption of the carbohydrate; the other method is by distilling the bituminous sulphur in mechanically agitated retorts. This method of fractional distillation gives practically pure sulphur with but traces of bitumins, but I found no mention of its commercial use, the H_2SO_4 silica gel method having the favor of the Inst. of Ore Dressing. I have brought a sample of both the first and second sulphur products; one, the bituminous autoclaved material; the other, the final sulphuric acid refined product from the Middle Volga ores.

POSSIBLE PRODUCTION

The mining end at these deposits will be the limiting factor in the production of sulphur in this district, regardless of the method to be used (open pit or underground).

An annual production of 50,000 tons sulphur is

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being projected for Vodina alone, an output (as far as the mining angle goes) that is not an impossibility for this deposit as there is sufficient area for opening up many pits,-in fact, one can visualize a 100,000 ton sulphur production from the mining angle,-but reason will eventually decree that an open pit method is the poorer of the two and that underground workings will be resorted to. In this case, in view of the many difficulties attending the latter system also, this Samara (Kuibyshev) district will do well to produce 20,000 tons of sulphur as a maximum instead of the present planned figure of 75,000 tons.

RESERVES

The varying widths of the sulphur bearing horizons as well as the occurrence of sulphur in pockets makes present estimates unreliable despite the number of drill holes and prospect shafts. The presence of sulphur at 11 widely scattered points, however, gives a certain amount of weight to the Soviets' claim that very considerable reserves of sulphur exist here. There appears no break in this formation for several thousand square kilometers but as surface waters have played an important part in the deposition of these sulphur horizons not all of this will be sulphur bearing.

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The following reserves have been estimated for the areas where drilling has been done:

Alexiev (10%)	1,250,000 tons	Possible Sulphur
Vodina (15%)	2,400,000 "	" "
Totals	13,650,000 tons of sulphur	

REMARKS

This district is favorably located in regard to transportation as the sulphur can be shipped to the south, east and west. Timber is scarce but water is plentiful and fuel may be brought from the Urals or from the southern coal deposits.

As has been stated above, the Middle Volga deposits will be extremely high cost producers: their grade so low and operating conditions so difficult that their place in the Soviet sulphur picture will depend to a considerable extent on the success or failure attending other higher grade but more remote deposits.

Mr. A. Steklov is the Communist Director and Mr. Polakov, the Technical Director.

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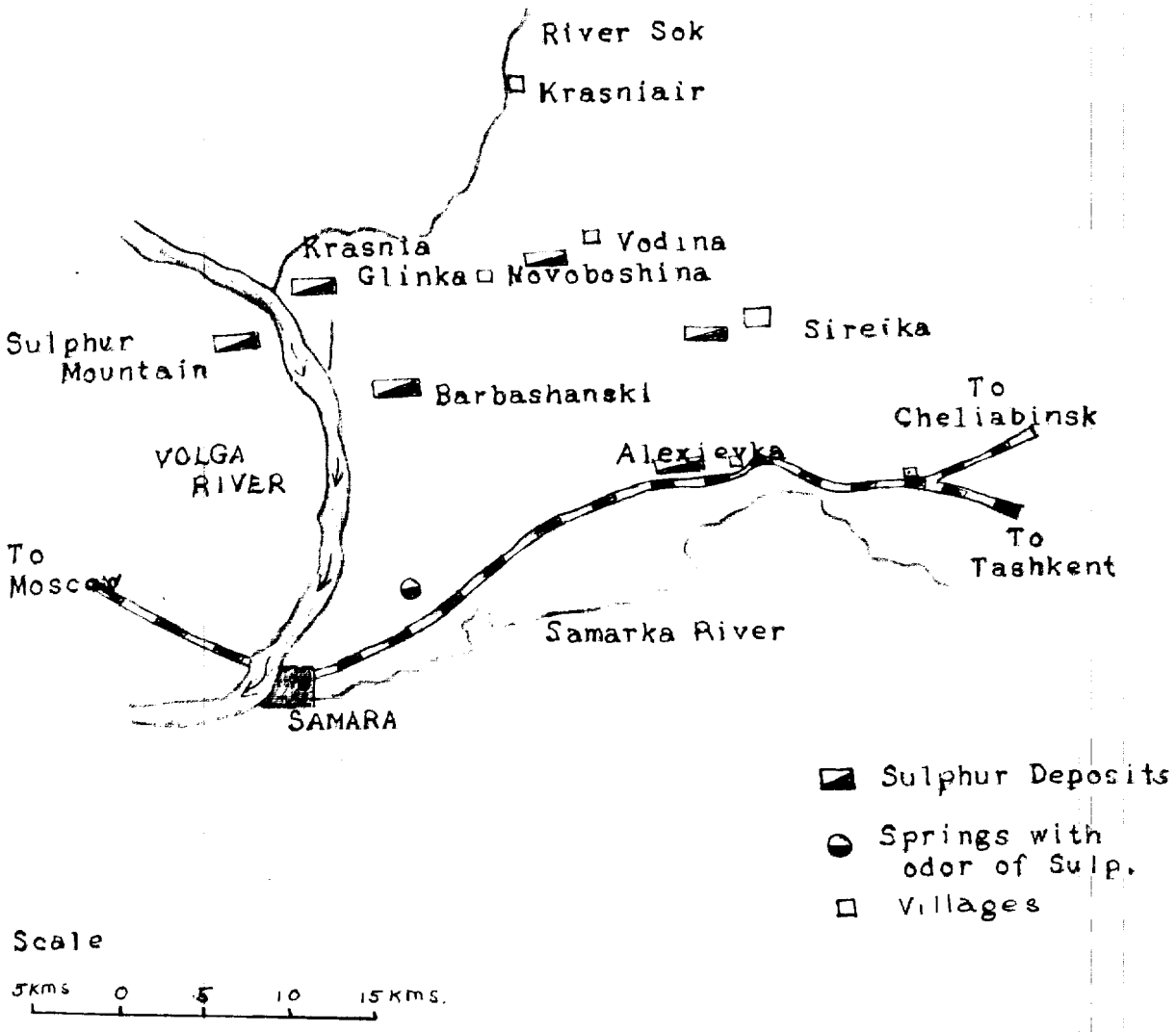
Sketch Showing location of Sulphur

Middle Volga Region



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MIDDLE ASIA

GAUHATI
(TURKESTAN)

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GAURDAK

LOCATION

Formerly a part of the Bukhara district of Uzbekistan but due to changes made by the Soviets in the boundaries, now included in the Kerbenski district of the Republic of Turkmenistan. The deposits of sulphur and salts are located on the western and southwestern sides of the Gaurdak mountain range. A wagon road 45 kilometers in length connects the camp with Charshanga, a station on the Samsonovo-Kelif railroad which passes near the southern tip of the Gaudark mountain range.

HISTORY

This deposit has been worked for centuries and shallow workings are still in evidence at various parts. Quite a collection of crude implements for mining and smelting the ore have been unearthed from the old dumps. The local nomadic tribes of eastern Turkmenistan have used sulphur in the manufacture of black powder for generations.

Up to 1916 very little was known of this district to the outside world as the Amu-Daria river was the only means of transportation. In that year, a Bukhara millionaire by the name of Stakeev and an engineer, Kovalevski, obtained a concession to build a railroad from Kelif to Samsonovo. This railroad was completed but during 1917 and 1918 parts of it were destroyed by the local tribes.

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In 1928 and 1929 a scientific expedition under the leadership of Stefanov made a reconnaissance in this district but their reports were so vague that it was necessary to send a second expedition into the field. This expedition under Miroshnichenko and Danov in 1930 made a fairly comprehensive survey of the district. From 1931 to 1933 exploitations were made but it was not until the year 1933 that any detailed exploration--shafts, drill holes, etc.--was started.

TOPOGRAPHY AND STRATIGRAPHY

The deposits are located along the southwestern flank of the Zaurdak mountain range which is a somewhat isolated uplift 700 to 800 meters above sea level or 300 to 350 meters above the surrounding area. The sulphur deposits are cut by deep ravines which clearly show the stratigraphy of the district.

On the western side of the Zaurdak mountains the Jurassic and Cretaceous formations can be easily traced. Along the crest, the Upper Jurassic limestones have been exposed while on the eastern side, Paleozoic metamorphosed schists, etc. are found.

The Jurassic sediments taken in order from the oldest up (see Geologic Column) are divided into the following groups:

I. Dark grey sandstones, clays with narrow beds of coal. The thickness of this division varies from 250 to 300 meters.

II. Dark grey limestone beds above which are found bituminous limestone beds which give off a distinct odor of H_2S. The thickness of this division is 300 meters.

III. The most important. It consists of limestone-gypsum beds about 200 meters in thickness. This formation is locally

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called the "Gaurdakski" and is in reality a part of the Jurassic and Cretaceous formations or, in other words, may be considered a transition between them. The lower part of this formation, about 60 meters in thickness, contain the sulphur bearing horizons of which there are two main zones. The upper zone is about 19 meters in thickness ("D" on geological column), the lower about 12 meters in thickness ("F"); in the upper part of this formation, the potassium and common salts are found.

The surrounding district has been folded into two large anticlines. The largest and best defined of these is that which forms the steep and narrow Kugitan-Tau mountains. The other anticline is more complicated, the Gaurdak, Gialimkan and Tube-Gatan mountains being small anticlinal folds along its axis.

Prospecting

To date four areas have been more or less prospected. They are as follows:

Area I. is located 1½ kms. north of the old Mohammedan Church and Cemetery. It has an area of 50,000 sq. meters. Extensive old shallow workings are found in the oxidized sulphur alluvials.

Area II is 1½ kms. northeast of No. I and is limited by 2 deep ravines, which clearly show the stratigraphy. It has an area of 800,000 sq. meters. The sulphur bearing limestone has a thickness from 2 to 20 meters.

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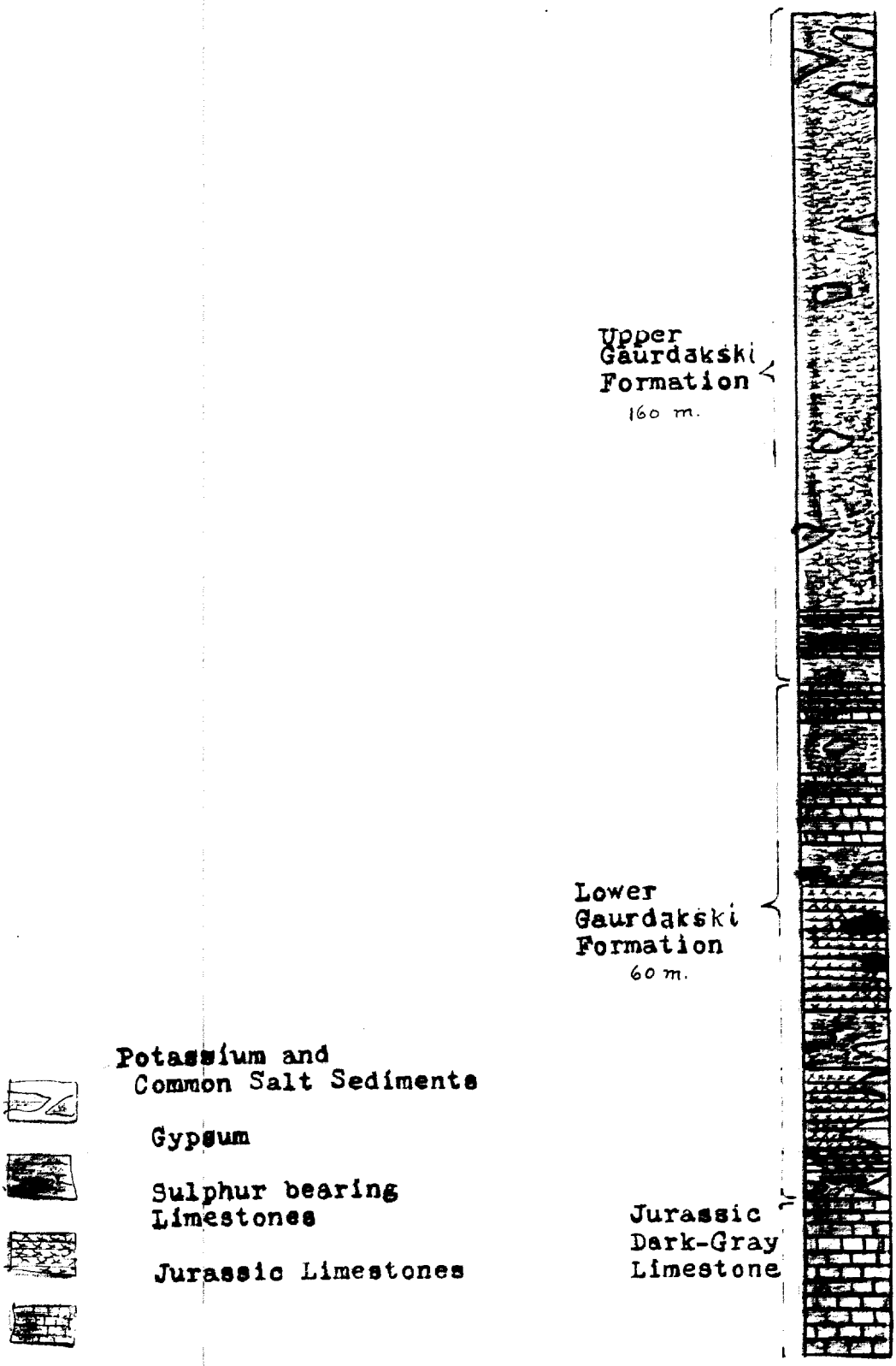

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Area III is north of No. II and separated fr m it by a precipitous ravine. It has an area of 70,000 square meters.

Area IV is 4 kilometers northeast of Area No. III and limited by deep ravines to an areal extent of 1,500,000 square meters.

The sulphur bearing limestones now under development are lying at a depth of 70 meters from the surface, the surface in some portions (Area No.I and IV) having a well oxidized sulphur zone 5 to 6 meters in depth. The sulphur bearing limestone beds of which there are two vary in thickness from2 to 20 meters. The upper limestone-sulphur bed has a sulphur content of 10% and the lower horizon, 20%. The sulphur is not evenly disseminated throughout the limestone beds as waste inclusions are encountered at frequent intervals.

MINING

There is some disagreement as to the method of mining to be applied to these deposits,-open pit or underground. If open pit methods are adopted, the proportion of waste to ore will vary from 3 to 1 or 4 to 1, which is a much higher ratio than used in any large open pit mine in U.S. In addition, the waste inclusions found in this deposit will not permit clean mi ing, with the result that the grade of ore recovered will not be over 10%. Preliminary estimate of mining costs by an open pit met od is 12 rubles, 50 kopecks per ton.

With underground mining methods an open stope system will be employed. This necessitates the use of large pillars for support as the average thickness of the sulphur bearing bed is in the neighborhood of 10 meters. Although the waste inclusions may be utilized to some extent for pillars, it may be considered that at least 20% of the total reserve of sulphur will be tied up in the form of pillars. The preliminary estimates of the cost of mining this deposit by underground methods is 7 rubles 80 kopecks.

The Frasch method of sulphur extraction has also been considered for this

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this deposit but the possibility of adopting it is remote and its application, if any, will be confined to the lower part of the steeply dipping sulphur bearing beds of the southern part of the deposit. In any event the application of this method is purely guesswork on the part of the local engineers. There is insufficient prospecting done in this portion to establish even the commercial presence of sulphur, and the above conjecture has been based largely on assumed extension of the sulphur bearing limestones in that direction.

METALLURGICAL OPERATIONS

The mine run of ore containing from 10 to 20 per cent sulphur is to be first crushed and sorted into three grades - waste, ore with contents of sulphur over 25% and low grade ore with sulphur under 25%. The high grade ore will be sent to Gill furnaces, the waste gases from which will be utilized for sulphuric acid manufacture (contact process). The low grade ore averaging from 8 to 10 per cent and the slag from the Gill furnaces will be sent to the flotation mill and the concentrates treated in autoclaves by the Volkov process described at Kara Kum.

Preliminary laboratory tests show that the recovery of sulphur with the utilization of the gases from the Gill furnaces should be 87 to 90 per cent. The flotation mill is expected to have a recovery of sulphur varying from 70 to 80 per cent.

SULPHUR PLANS

The sulphur plant is projected for an ultimate annual capacity of 50,000 tons. Designs are still under way though preliminary

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construction of parts of the extensive Chemical Combinat has begun.

ORE RESERVES

The Gaurdak deposit is the largest known sulphur deposit in Soviet Russia. Numerous estimates have been made. Various Soviet engineers connected with the Inst. of Ore Dressing were inclined to call Gaurdak a 300 to 500 million ton deposit - entirely wishful thinking - the deposit being, as yet, quite without adequate exploration. These large estimates have been prompted by recent cursory examinations in the vicinity by Geologists who believe that the anticlinal domes forming the Karabil, Kattaur and Kundaiang-Tau mountains (located west of Gaurdak) are also sulphur bearing. In the Karabil mountains, the sulphur bearing limestone formation outcrops to the surface while at Kattaur and Kundaiang-Tau it is thought to lie at some depth below the surface. Although the "Gaurdakski" formation is fairly extensive, there has been insufficient prospecting to warrant sulphur over so large an area. If future prospecting proves the presence of sulphur bearing beds at some depth below the surface in the Kattaur and Kundaiang-Tau mountains, there is the possibility of the adoption of the Frasch process at these points.

The reserve of sulphur in proven ore is 700,000 tons with 2,000,000 tons proven by contour only, that is, by tracing the sulphur bearing limestone beds where visible along the sides of the ravines.

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POSSIBLE PRODUCTION

OPEN PIT - This appears to be the proper method to be adopted here due to the presence of Potassium and Common salt above the sulphur bearing beds. Nevertheless, in order to mine sufficient ore to maintain a production of 50,000 tons of sulphur yearly, a large amount of ore and waste must be removed for the ratio of ore to waste is 1 to 3, With shovel operations, the average grade of ore should not exceed 10% sulphur. Taking one ton of 10% sulphur ore (90% limestone) as 13.5 cubic feet in volume, it will be necessary to mine approximately 5½ cubic meters of ore for each ton of pure sulphur (metallurgical recovery taken as 70% overall). Therefore, 22 cubic meters of ore and waste must be moved or with a 50,000 ton sulphur production, 1,100,000 cubic meters must be handled yearly. This is not all as some of the above sulphur ore will be converted into sulphuric acid or some of it will be utilized for sulphuric acid production due to the gases of the Gill furnaces. Therefore the above total tonnage figures can be increased by 10 to 20 per cent or in round numbers 1,500,000 cubic meters yearly.

The removal of waste is relatively simple here as the ravines and side hills offer good locations for this operation. On the other hand the potassium and common salt must be mined at the same time as the sulphur and waste. These operations going on simultaneously in the same deposit will undoubtedly cause many difficulties in transportation, shovel operations, and in layout of the pit. In addition, the sulphur and salt areas are cut up by the ravines into small parts making each a

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relatively small unit available for working. But, according to the areas now explored, it appears that from 8 to 10 shovels are about the proper number to be used here. With, say 10 shovels in operation, each with a daily capacity of 500 cubic meters, about 1,500,000 cubic meters would be the yearly production. This should, apparently, give the 50,000 tons of sulphur for which the Gaurdak plans call.

UNDERGROUND MINING

If this method is used, however, the grade of ore will be cleaner with an average approximately 15%, but the large amount of development necessary will not, I would estimate, permit a yearly production higher than 30,000 tons of sulphur.

In either case, regardless of the method of mining to be used, the sorting of the ore will be a difficult problem and will cause many delays.

REMARKS

This district is considered by the Soviets the most important potential producer of sulphur in the Union, and it has additional value in its common salt, potassium salts and oil. East of Gaurdak are the districts of Shirabadski, Baisunski, and Guzarski - located in the Uzbekistan Republic. In these oil, coal, common salt and polymetallic minerals are found. The rock salt horizon in the Shirabadski and Guzarski districts is different from that in Gaurdak as it is not accompanied by potassium salts. Sulphur is said to exist in the Shirabadski district but it is not claimed that the deposits are large.

West of Gaurdak is the Kizil-Aiski district in which

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elaborate irrigation projects are well under way along the Kelif-Uzboi river. These plans include the irrigating of the southern part of the Kara Kum desert. The right bank of the Amu-Daria will also be irrigated by raising the water level some 20 feet. All these elaborate irrigation plans will open up a large agricultural region.

Northwest of Gaurdak is the city of Chardjui where paper, canning and textile mills are under construction. The Soviets intend to make this city the Capital of the Turkmenistan Republic due to its industrial importance.

Two sources of power are available - oil and water. Three hydro-electric power stations are under construction along the Amu-Daria river (which also fit into the irrigation scheme previously mentioned) from Kelif to Kerki and which will have a total capacity of 71,000 kw. This amount of power is not sufficient for industrial and social needs but can be augmented by steampower plants using oil and in some cases the bituminous limestones which have as high as 47% carbon. The oil deposits are well scattered throughout the nearby districts. In 1934, in sinking a small shaft near Gaurdak, a light oil was encountered at a depth of 22m. This leads Soviet geologists to believe that oil in commercial quantities may be found immediately adjacent and an intensive prospecting campaign is under way.

Although no railroad branch connects Gaurdak with the main line at the present time, it cannot be said that it has an unfavorable location in respect to the transport system in this region. It is located in the zone of railroads from Tadjikistan to European Russia. The railroad from Alexandre-Gai to Chardjui

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will be extended to connect with the Stalinbad branch through the station at Kerki. With the industrialization of this region the Amu-Daria river will also be used for transportation - all of which should afford an adequate transport system and one which will place Gaurdak in a favorable position to supply all agricultural and industrial districts.

The Amu-Daria river, although some 50 kilometers away from the sulphur and Chemical plant sites, offers a good supply of water. The labor question is acute at the present time and with increased tempo of construction work of all these varied industries, railroad hydro-electric plants, irrigation, towns etc., a shortage of labor will be evident in the immediate future.

One small Gill furnace was in operation during 1934 and produced 1,500 tons of sulphur. Another furnace is nearly completed. The sulphur flotation plant construction work is progressing very slowly and the Soviet plans of having this plant in full operation in 1937 will, at the present rate of construction, not be realized.

The present plan of having the sulphur, common salt and potassium salts under separate managements and in no way connected with each other, will undoubtedly delay construction and cause much friction. This is now evident at every turn. The Soviets have ranked the sulphur to receive the most attention but how long this will be so remains uncertain.

CONCLUSION: This district is in reality the best of Soviet sulphur potentialities. It will have a good local demand. It has large reserves, and is favorably located in respect to power,

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water and transportation. It is problematical whether this deposit under a competitive system in which foreign sulphur would be allowed to enter Russia, would have any other than local significance. The long rail and water haul from European ports about balancing the high mining and metallurgical costs.

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MIDDLE ASIA REGION

KARA KUM DEPOSITS

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LOCATION

This group of sulphur deposits lying in the center of the Kara Kum desert is found within the 39 and 40 degree, 30 minute North Latitudes and the 58 and 59 degree East Longitudes. They are located 250 kms. south of the Kopet Dag mountain and 500 kms. east of Karabujaz Bay on the Caspian Sea. The nearest railroad point to the Zeagli sulphur plant is Ashkhabad on the Middle Asia railroad some 250 kms. south. From this point all materials and passengers are taken into the desert by camel caravans, automobiles or airplanes. Over 500 Renault cars of six wheel construction or of a type used by the French in the Sahara desert are in use for transport from Ashkhabad to Bochurdok, 110 kms. distant. Here the shifting sands begin and materials are transferred to camels for the remaining 140 kms. trip to the Zeagli sulphur plant and then on to the Darvaza sulphur plant which is 60 kms. northwest. Passenger cars travelling six to a caravan for safety, and for aid to each other, travel the whole distance through Bochurdok, Mamed-Sai, Serbent, Zeagli to Darvaza. The speed is very slow due to sand storms, shifting sands, high winds and extremes of heat (May to September 1, maximum 55 deg. C.) It is not unusual for a car loaded with material to make but 4 kms. a day during the winter months when high winds prevail.

At Ashkhabad and Bochurdok,-the latter being the transfer station,-piles of materials are lying around waiting for shipment to the sulphur plant. The road is also strewn with wreckage and

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discarded materials. Despite the high cost of transportation and all the difficulties experienced with travel over several years, very little work has been done to better the road conditions. By auto it takes two to three days, under good seasonal conditions, to make the journey into Darvaza.

The quickest and best means of transportation are the four airplanes in use. These airplanes transport sulphur, small machinery parts, and Soviet officials. The trip takes less than two hours.

HISTORY

These sulphur mounds were accidentally discovered by some Army men who were mapping this district in 1881. Some efforts were made at various times to work these deposits, the latest pre-Revolutionary attempt being made in 1917 by a Jew who worked them on a small scale. The difficult living conditions, the high cost of transportation and other factors made all these efforts short live . In 1925, the Academy of Science in an attempt to relieve the Soviet Government from the necessity of importing sulphur sent an expedition to examine these deposits. This expedition under the leadership of Academician Fersman, spent several years mapping, exploring, etc., and during the course of their explorations discovered additional sulphur bearing areas in the vicinity of Zeagli. In 1928 a small experimental plant was built by P. A. Volkov near the Zeagli sulphur mound. In 1930 the Academy of Science again sent an expedition under Fersman for more exploration work and the Darvaza group

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of sulphur mounds were discovered. At the latter place, a town of 2,000 inhabitants, movie theatre, etc., are found where only a few years before was desert waste. A steady, small output of sulphur of 99.95% purity has been maintained since 1931 - though under severely adverse conditions.

GEOLOGY

The desert Kara Kum ("Black Sands") can be divided into two parts; the northern, starting from Unguz, a plateau; the southern, lowlands. The former is composed of Neocene sandstones, clays and marls in which are found Lower Sarmatian fauna. The sulphur mounds form a system of small hills that are apparently the remains of a higher plateau long since eroded by wind and rain.

The zone of oxidation of these sulphur mounds consists of a complex of oxidized and decomposed rocks, - discolored sandstones, gypsum and unusual alumino-silicious formations. Beneath this zone are found interbedded clays and friable, silicified sandstones which form the floor of the sulphur deposits.

DEPOSITS

The sulphur mounds (more than forty in number are known but not all have been prospected) are in two groups - northern and southern. The northern contains the greater number of mounds, and the bulk of the sulphur reserves. The southern group, at which the first sulphur plant was erected and which at present produces the sulphur, consists of the Zeagli, Dengli, Top-Djulba, and Chemerli mounds. The sulphur ore, a fine grain

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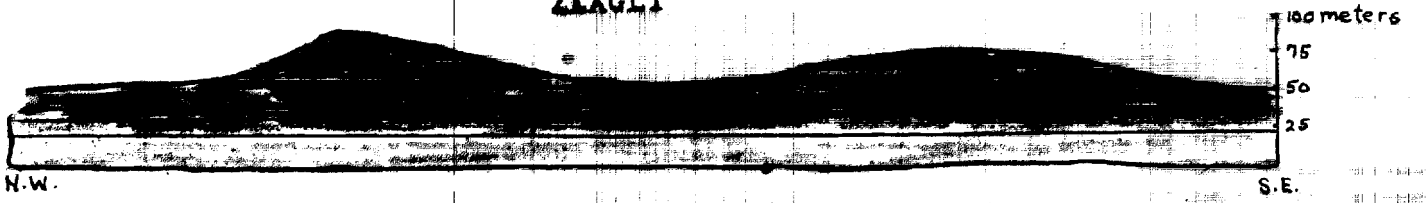
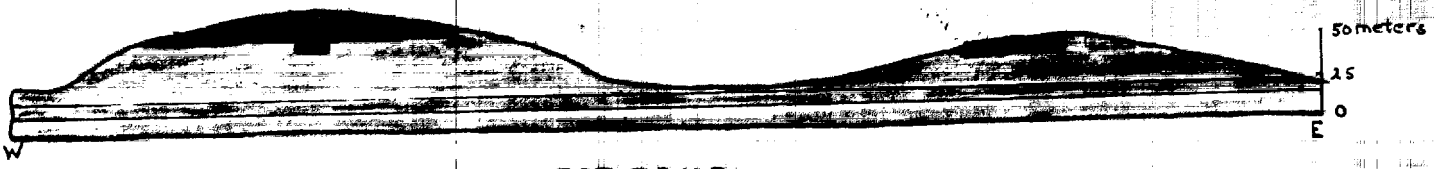
CROSS SECTION OF SULPHUR MOUNDS
KARA KUM DISTRICT

3

ZIAGLI



TOP DJULBA



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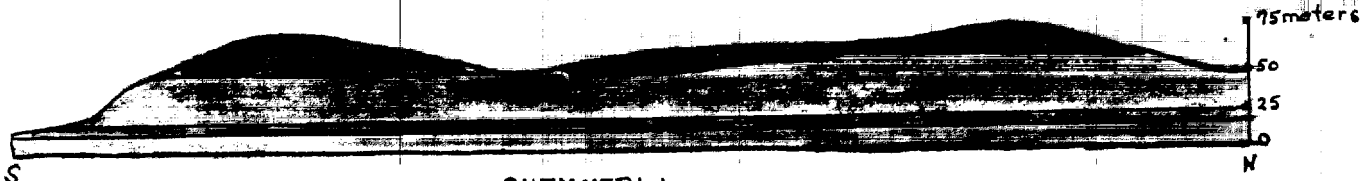
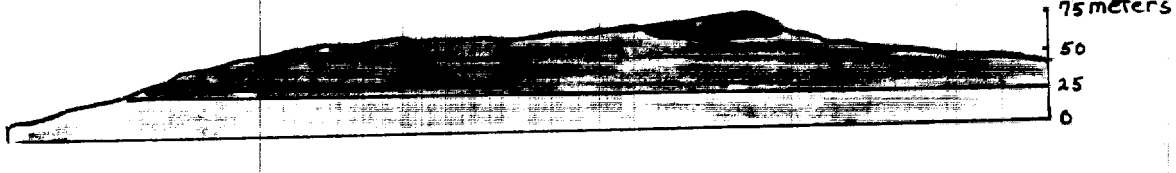


CHEMMERLI

KALTAMAN DJULBA



LEGEND

- SANDS
- SULPHUR BEARING SANDSTONES AND CLAYS
- RED AND GRAY COLORED SANDSTONES
- BRIGHT COLORED SANDSTONES WITH GYPSUM AND CONGLOMERATE
- DIAGONAL SANDSTONES (tilted)
- GREEN & BROWNISH CLAYS WITH MARL AND LIMESTONE

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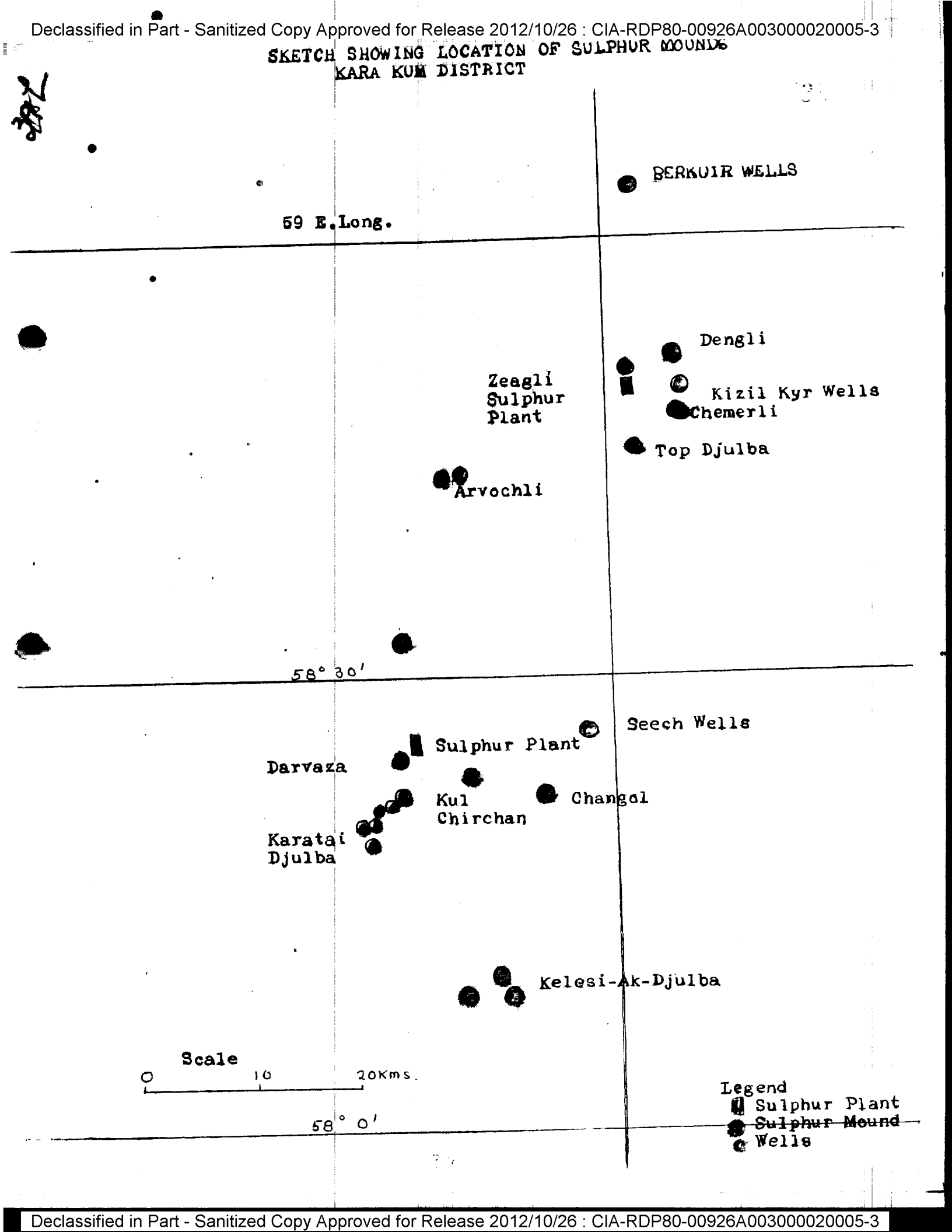
SKETCH SHOWING LOCATION OF SULPHUR MOUNDS KARA KUM DISTRICT



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quartz sand cemented by sulphur, occurs largely in nest-like form but in some mounds (as Zeagli) as a bedded lens. The mounds, varying in height from 10 to 70 meters above the surrounding surface, contain as a rule, approximately one-fifth of their volume as sulphur ore: a few of the mounds, however, carry a considerably heavier proportion of ore. The grade of the ore is 25 to 40 per cent, samples of the various formations ranging from 18 to 70 per cent. The nest-shaped deposits are several meters in cross section and usually lie close to the surface of the mound.

MINING

Pick and shovel is the principal method used for the working of these deposits as the ground is fairly soft and little blasting is necessary. The overburden or waste encountered in mining is removed by camels in small carts. The absence of power in this district makes all mining operation by hand and no attempt has been made to mechanize. The ore is sorted very closely by hand, sacked and transported by camels to the sulphur plant near the Zeagli mound.

TREATMENT

Extraction of pure product from the sulphur-cemented fine grained sand was for some time a difficult problem. A Calcaroni furnace was at first installed (1930-31) but gave poor results. A Soviet Chemist P A Volkov finally devised an autoclave treatment, or "smelt", in which a small amount of water is added to the ore, in a small iron tank (See sketch) to which after sealing,

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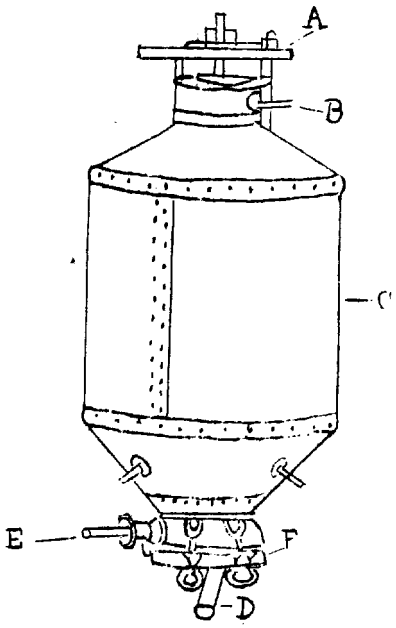
SKETCH OF VOLKOV AUTOCLAVE



A - Cover for charging ore

B - Steam inlet

C - Tank

D - Sulphur outlet

E - Water Inlet

F - Discharge cover

(Dimensions unobtainable - Units small.)

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steam under a pressure of about 6 atmospheres is introduced. The temperature is raised to between 120 and 150 deg.C., the sulphur melts and in the liquid mass which is constantly agitated by the steam, sand rises and sulphur collects at the bottom. The process, from the charging to the unloading in the small tanks used, takes two hours approximately.

The molten sulphur, tapped from the bottom of the autoclave, is cast into forms. The waste or tank tailings carried considerable sulphur which, until about a year ago, stuck to the gangue, and prevented high recoveries. The Institute of Ore Dressing at Leningrad discovered in 1934 that the addition of 1 per cent tannic acid, or the same amount of $CaSiO_2$, in the autoclave, accelerated the separation of the last sulphur particles from the gangue (by effecting an increase in the "angle of separation" of the globules), and the Volkov process now gives high recovery and a 99.94% to 99.98% grade of sulphur at the sulphur plant near Zeagli.

There is left in the autoclave tails, however, 2 to 5 per cent sulphur. A Soviet designed electromagnetic machine (Pirker) was shown to me at Mechanobr (Mechanical Experimental Laboratory, Leningrad; during August 1935) which was making an almost perfect separation of sulphur from these tails. This Pirker machine is to go to Zeagli and to Darvaza, where a new sulphur plant is under construction.

This Volkov process, or autoclave, is apparently the Soviet adaptation of U. S. Patent 1,374,422 (G.A. Bragg, assignor to T.C.S. Co.). At Institute of Ore Dressing, Leningrad, Director

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Berkin and his assistants were emphatic in their statement of advantages that had resulted from the recent discovery of tannic acid (and/or calcium silicate). As in countless other instances of "inventions by Soviet scientists" no mention is made, in press or personal discussion, of foreign patents or machines from which they have been taken --- they have all been "discovered by brilliant" native engineers working for the millenium.

RESERVES

The reserves are variously estimated from 500,000 to 5,000,000 tons metallic sulphur for this district. The latter figure takes in all mounds whether sulphur bearing or not. The reserves recorded by the first expedition (1926) were 500,000 tons. Subsequently, new mounds gave an additional 700,000, with more mounds still to be explored. The following estimate appears reasonable according to visible date:

Name of Mound	RESERVES
Northern Group	
Darvaza	188,000
Kelesi-Ak-Djulba	300,000
Karatai-Djulba	200,000
Arvochli	100,000
Total	788,000
Southern Group	
Zeagli	100,000
Dengli	134,000
Chemerli	38,000
Top-Djulba	85,000
Total	357,000
TOTAL BOTH GROUPS	1,145,000

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The southern group is well prospected and thus offers little opportunity of increase in its reserves above. The northern group, containing the greater number of sulphur mounds, offers an excellent opportunity of increasing the above reserves considerably.

[redacted]

In this district the sulphur output will not be limited by mining operations as the mounds are numerous and are easily worked. The limiting factor will be the water supply, not only for plant operation but for human consumption. The water requirement for the southern sulphur plant now operating near the sulphur mound Zeagli is about 3,000 gals. per day when the plant is operating full capacity of 2,000 tons sulphur a year (twice the 1000 ton production of 1934). Water is brought by camels from two wells - Kizil Kyr and Berkuir. One gallon of water from the former costs 8 kopecks (12½ gals. to the ruble) from the latter, 5 kopecks (20 gals. to the ruble.) The water from the Kizil Kyr well is the better but this well has a limit of approximately 700,000 gals. per year which limits the plant to approximately 233 working days at full capacity. If more than this amount of water is taken from the well, it runs salt water for a long length of time; therefore, observations over a number of years by engineers in this place have taught them not to exceed this amount. The water from the Berkuir well has slightly less capacity but it must be used for both town and plant.

In the northern group of sulphur mounds, the water for the sulphur plant at Darvaza must be brought from Seech wells. While these wells have a larger capacity than those for the Zeagli

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plant, they do limit the sulphur production.

Until that time comes when control of abnormal conditions will permit a railroad line, this district cannot hope for a larger production than 5,000 tons yearly and this figure includes the operation of two sulphur plants - one at Darvaza and the other now operating at Bengli. The construction of a railroad line will not entirely solve the problem here, as water will still be scarce. The only possibility for this district to become a large producer of sulphur is the proposed irrigation scheme of the future in which the Amu Daria river will be turned into the desert.

If an adequate supply of water as well as cheap transportation is made available, this district is a potential 100,000 tons sulphur producer.

REMARKS

The region - as is true of all this remote southern border country - is one of filthy hybrid felt yurts, crumbling, mud-walled vermin infested houses and half built modern warehouses - food pitifully scarce at times, with poverty and disease that is almost beyond imagination. The nomadic tribes have never been fully disciplined and regimented into step with the rest of Soviet Russia and for the past two years the U.S.S.R. have refused admittance to tourists to any and all parts of this Middle Asia border region (extending along the northern bounds of Persia, Afghanistan and India) largely because of continuing minor outbreaks. Into this primitive low grade scale of living and

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industry the Soviets standards and tempo are beginning to penetrate; schools, shops, restaurants, dispensaries, automobiles, airplanes are being gradually introduced. It is announced (summer 1935) that regular automobile and airplane service has become established between Kara Kum and Ashkhabad, - a "regularity" that will be largely on paper for a year or so yet. When the abnormally difficult and expensive production of sulphur here is considered, one is led to wonder whether this Kara Kum industrial project is not a blind to force the iron rule of the Soviets over these nomadic tribes, who have found the Kara Kum desert their last frontier of freedom.

Strange as it may seem there is no shortage of common labor at the sulphur plants as it is estimated that 100,000 people inhabit this desert region. The labor turnover is high, and will continue to be so, as the people are essentially a stock growing race and will only work a certain length of time to obtain certain commodities that the desert cannot furnish them. The skilled labor is recruited from the outside but the stay is usually short. It will take years of persistent effort on the part of the Soviets to regiment these people, a change, incidentally, that will be at the expense of cattle raising.

Fuel is obtained from the small woody bushes which grow in the vicinity but as this supply is scarce, plans have been made to replant in order to replenish the supply. Outside fuel, such as wood, costs 200 rubles per cu. meter, delivered at the sulphur plant.

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The determination to get sulphur out of these Kara Kum deposits despite the high cost of transportation, the difficulty of obtaining water and the well-nigh impossible conditions of the region in general, throws no little light on the Soviet conception of industrial possibilities and economy. The lack of fuel, water and transportation would naturally lead one to think that the introduction of Gill furnace or some other method in which water and fuel, other than that in the sulphur ore itself, is not used, would be the proper method to install. Instead, they have introduced a method in which to be sure, a high recovery is made but with which at the same time their production is limited and a local woody growth essential to combatting soil erosion is being used up.

A small amount of this sulphur is exported to Northern Persia. Camel caravans come in from the latter place and barter wool for the sulphur which is used solely for sheep dip. By no stretch of the imagination would this export ever be considered large.

CONCLUSIONS

Although this district has the highest grade sulphur ore in the Soviet Union and could probably produce 100,000 tons yearly if water and fuel were available, it will be some years before adequate transportation is available. Furthermore, not only a railroad but the Amu Daria irrigation scheme must precede any important tonnage. The cost of producing a ton of sulphur here at the present time is tremendous - no exact figures being

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given out. The status of the region may be considered more as a political affair than as one economically sound. The construction of a permanent plant is progressing but slowly; it is estimated that 20,000 camels are needed, a number not to be had.

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MIDDLE ASIA

SOVIET

PERSIAN VALLEY DEPOSITS

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FERGANA VALLEY

LOCATION

The Fergana Valley is located in the southeastern part of the Uzbekistan Republic and the northern part of the Tadjikistan Republic. On the north it is bordered by the Kurmanski and southern Chatkalski mountain ranges; on the south, by the Alaiski mountains; and, on the northeast by the Fergana mountains. The valley is served by a branch of the Middle Asia railroad.

Geographically the oil deposits and associated sulphur deposits of the Fergana Valley divide into three groups:

I Southern Group - comprising those oil deposits lying south of the southern branch of the Fergana Valley railroad, is the most important. The oil seepages in this district are found in an east and west direction for 160 kms. - the Tash Ravat being the most western known oil seepage and the Chomion, the eastern. Some oil production comes from the latter field.

II Northern Group - comprises those oil indications lying north of the northern branch of the Fergana Valley railroad. Oil seepages have been found here in an east and west direction for 110 kms.

III Eastern Group - comprises two known oil deposits which are located slightly to the northeast of the end of the railroad.

In drilling and prospecting for oil in this valley, several indications of sulphur have been found but only a few have been prospected to any extent. The most important of these deposits are the following:

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SHOR-SU

LOCATION

Shor-Su is in the Southern Group of oil fields, 36 kms. southwest of Kocand, a junction town on the Fergana Valley railroad. The valley plain, covered with alluvials of the Sir-Daria river and its branches, is fertile along the river banks and is under cultivation to some extent.

TOPOGRAPHY AND STRUCTURE

The automobile road from Karaganda to the sulphur deposits at Shor-Su is very rough and rises gradually over a series of up-lifts or folds formed by the up-lifting of the Alaiski mountains. Behind these folds are the snow covered Alaiski mountains.

To all appearances the Fergana Valley was not seriously disturbed by the up-lifting of the Alaiski mountains. The folds varying from 3 to 5 in number have a horseshoe-like form around the northern, southern and eastern sides of the valley. The oil and sulphur are, in general, found in the second and third folds (numbered from the Alaiski mountains) in the Eocene formation.

DEPOSITS

In the Shor-Su district are found four anticlines. The first and second anticlines are fairly close to each other. The third anticline is about one kilometer to the northeast of the second and the fourth is to the south of the third anticline. Oil and natural gases are found in the Tertiary sediments of the fourth and second anticlines. This Tertiary forma-

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tion is represented by orange, red, yellow and green colored clays, limestones and marls. This formation is locally known as the Fergana.

The first and third anticlines in which the sulphur is found has been denuded to the gypsum (Lower Cretaceous) formation. which underlies the Fergana. The sulphur ore is found in cracks or filling cavities, sometimes in a highly pure state.

METALLURGICAL OPERATIONS

At the present time, a 75 ton flotation mill and autoclave plant - floating sorted ores to 90% and then autoclaving to 99.5% - is in operation. The autoclaves are the same design as the Volkov autoclave used at Kara Kum. At the present time the ore is hand picked, the better pieces sent to the autoclaves directly. The second sort ore 10 to 15 per cent is sent to the mill but due to the lack of power, mechanical repairs, etc., the mill operation is very irregular.

MINING OPERATIONS

The sulphur is found irregularly distributed in cracks and cavities. The overburden 1 to 4 meters is stripped by drag line excavators and two power shovels (all in need of repairs). The sulphur indications on the surface are then followed by small prospect shafts, and if found commercial, by underground work. In sinking these small prospecting and underground openings, large amounts of H_2S gas are often encountered and the work delayed. In underground work as blasting is necessary, fires often break out (the Soviets have no short flame dynamite) which causes additional expense and delays.

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In general, the present mining work is haphazard and crude but the nature of the ore occurrence demands this to a large extent. The use of numerous small shafts is a policy which leads to high costs and confusion. On the other hand, the use of large shafts and the driving of numerous crosscuts and drifts throughout the deposit will also add to the costs, because of the relatively large amount of development necessary. As it is, if a fire occurs in one of the small shafts, the locality can be shut down and work started at other places. With large scale operations as planned, a fire in any one place may seriously interfere with work in others that may be connected by mine development work. The ore is transported to the mill by cableway.

RESERVES

Various estimates have been made for the Shor-Su deposits - some of them as high as 1,000,000 tons of sulphur. Due to the irregular occurrence of the ore, and lack of prospecting in advance of mining, this figure appears too high. The following estimate, although high in the proven and possible categories, is more in accord with the known data:

A B C-1	350,000 tons	Sulphur 16 to 17%
C-2	300,000	
	650,000 tons	

The above estimate includes ore as low as 5 per cent sulphur.

PLANS

The chemical Kombinat at Shor-Su plans to make sulphuric acid from the poorer ores and gypsum, for use on the Chaidarkan

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and Karamazar polymetallic ores. Two new modern towns are being constructed: one at Shor-Su and one at Melnikovo. The yearly sulphur program, calls finally, for 60,000 tons of sulphur and 50,000 tons of sulphuric acid, construction plans for the different parts of the Kombinat contemplate three periods. First period, 1933-35, organization of projecting work and beginning of sulphur and acid plant construction. Second Period, 1935 to 1937, development of the salt and chloride plants and completion of the sulphuric acid and sulphur plants. Third Period, 1937 to 1939, completion of all chemical plants and development of oil and coke.

To date, the projecting end of the first period has been completed but construction is far behind.

POSSIBLE PRODUCTION

The planned capacity of 60,000 tons of sulphur yearly seems a fantastic figure when one views the difficulties they are now having to produce 1,300 (1934 production) to 2,000 tons (est. 1935), and despite the planned introduction of additional mine equipment. Severe mining obstacles at this deposit are: delays in development, presence of H_2S gas, mine fires, labor shortages, and difficulty of prospecting. Basing an estimate on present operations and taking into consideration the possibility of improvement, the maximum production possible from this deposit should not exceed 10,000 tons of sulphur.

The planned program of 50,000 tons of sulphuric acid should be performed as the gypsum and low grade ores are wide spread and

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easily obtainable. On the other hand, it is difficult to conceive that this plan will stand up for any length of time as there are large reserves of pyrite ore in Middle Asia as well. (See Pyrite Section of Report.)

REMARKS

Shor-Su, surrounded by complex mineral and agricultural resources, is the geographic center of the well inhabited South Fergana district. Though regarded as a mine of large reserves by the Soviets and fairly well equipped, it has failed to perform its planned program, due to poor technical management, difficulties in mining and the planning of mining operations, bad living conditions, lack of water supply, placing of waste dumps where they interfere with mining operations, and in general, the poor quality and small amount of ore mined in relation to the resources. In addition to sulphur the Shor-Su Kombinat includes wide assortment of other useful minerals; to the northwest, the Kamish Kurganski common salt deposits and the Naukutski copper deposit (which will require sulphuric acid in future treatment.) Still further northwest, the Karamazarski lead zinc deposits. To the southwest, the Churabaski coal deposits are the largest in Middle Asia. The Fergana district produces cotton, wool, sulphur, coal, oil, gas and has flourspar, antimony and selenium possibilities. In addition, a 100 kilometer circle includes showings of the construction materials - limestone, gypsum, magnesite and asbestos. The main line of the Middle Asia railroad connects the Shor-Su kombinat with Moscow, Krasnovodsk (on east shore of Caspian), Siberia, and the Turksib R.R. outlet to Transiberian R.R.

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and far east.

The exploitation of the sulphur deposits goes on amid all the other work, but the Shor-Su situation at present is one of considerable confusion. It is too far removed from the Moscow center for effective control, and it will be several years, even under the urge that exists for sulphur, before the sulphur development can be at full swing.

The labor is largely recruited from the nomadic tribes; therefore, it is inefficient and large labor turnovers can be expected for some time to come. Power will be available from hydro-electric stations under construction at the following points - Narenski, capacity of 80,000 kw. on Sir Darya river; Kuvassae, 26,000 Kw. and Uch Kurgan, 24,000 Kw. on the Isfara river.

OTHER SULPHUR INDICATIONS (Fergana Valley)

According to information received from K.P. Kalitski, V.N. Veber and I.M. Gubkin, ranking geologists in the Middle Asia Oil Trust several indications of sulphur were found during their drilling for oil in the Fergana valley. These indications are at the following points:

South Group of Oil Fields

Kim Field - known as the Santo in pre-revolutionary time. It is located in the Tadjikistan Republic 16 kms. south of the railroad town of Kolnikovo or approximately 50 kms. southwest of Shor-Su. This Kim field and the Sel-Rocho field nearby, and another small deposit, Bitau, north of Shor-Su, are being prospected. The sulphur is found in the denuded crests

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of the anticlines in the Cretaceous gypsum which underlies the oil formation.

Rishtan field is located 30 kms. south of Servo, a railroad station on the Kokanda-Andizian southern branch of the Fergana R.R. This deposit has also been denuded to the gypsum. Not under development, reserves not apparent.

Kamish-Bashi has been definitely rejected as an oil possibility as three long holes here did not prove the presence of oil, one hole gave small indications of sulphur. This deposit has also been denuded to the gypsum.

Northern Group of Oil Fields

Changir-Tashski belongs to the northern group of oil deposits which as a whole are not important oil producers. It is located 12 kms. north of Yon-Abad, a station on the Andizian-Kok Angar northern branch of the Fergana Valley railroad.

Pitsau-Sai is also located in the northern group. Several holes showed small amounts of sulphur.

REMARKS

These drill holes at widely scattered points, although showing small amounts of sulphur, are not indicative that the Cretaceous gypsum formation underlying the oil formation is sulphur bearing as Soviet geologists assume, in giving estimates of 40,000,000 tons of sulphur for the Fergana valley. In none of these above named districts has check drilling been done to determine the extent and

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grade of the sulphur. In all cases the sulphur has been found only in those localities where denudation has played an important part and which have been exposed along their crest, down to the Cretaceous gypsum formation which underlies the oil formation. In the producing oil districts in this region, all near the surface, the oil is noted for its high sulphur content, which leads one to believe that the sulphur of the region is also close to the surface, with little possibility of applying the Frasch system.

There has been such a demand for oil that the Oil Trust has given little thought or aid to the sulphur industry and has utilized all available drilling equipment.

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OIL SEEPAGES

1. Tash-Ravat
2. Sel-Rooho
3. Kamish-Bashi
4. Shor-Su
5. Rishtan
6. Chemion
7. Changir-Tash
8. Kulmen
9. Maili-Sai
10. Shiyng
11. Enku
12. Pitau
13. Maili-Sai
14. Varzik

DISTRICT NOW BEING DRILLED

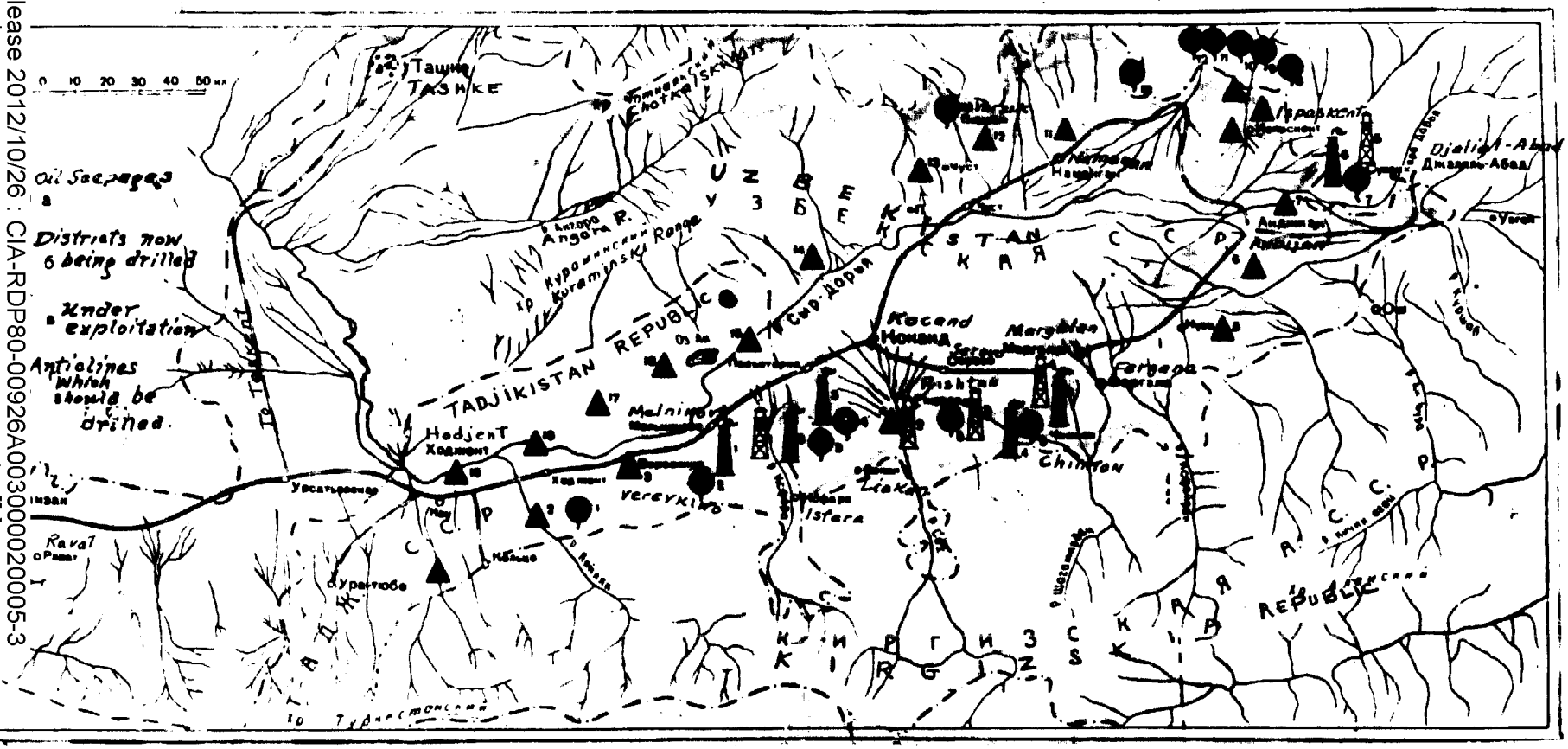
1. Iaritan
2. Loch
3. Rishtan
4. Kapchagai
5. Large Changir field

DISTRICT UNDER EXPLOITATION

1. Kim
2. Nefteabad.Chanobad-Sai
3. Shor-Su
4. Iarkutan
5. Chemion

ANTICLINES WHICH SHOULD BE DRILLED

1. Zaambarichski
2. Kushluk-Kairagach-Togap
3. Tuzluk
4. Ist.Lochskia
5. Kuvinski
6. Andijanski
7. Alma-Mishik
8. Espaskentski
9. Maili-Sai IV
10. Maili-Sai III
11. Namanganski
12. Kaisansanski
13. Chust-Papski
14. Munganski
15. Supe-Tau
16. Ak-Bell
17. [illegible]
18. Kuchad
19. Bem-Bai



GUY C. FINDELL AND ASSOCIATES
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CHEKOR KOYASH

CRIMEA

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CHEKUR KOYASH

LOCATION

In Crimea, European Russia, 45 kms. southwest of the city of Kerch and about 2½ kms. from the sea.

DEPOSITS

The deposits consist of a series of sulphur bearing clay and gypsum beds of Cretaceous age of which only one bed has a mineable grade and width. The sulphur bed mined at the present time has a length of meters and a width of 1.3 meters. The average grade of ore in the southern part of the deposit is 17.5% while the grade in the northern portion averages 10.8%. The bed strikes approximately north and south and dips to the east at an angle of 30 degrees. In exploring this deposit at a depth of 200 meters, a drill hole proved the continuation of the deposit but a fault in the hanging wall leads geologists to believe that this bed will be cut off in depth.

RESERVES

Despite the presence of the above mentioned fault, the geologists have estimated this deposit to contain 60,000 tons of sulphur. This estimate is probably out of bounds as it includes possible and probably ore for a continuous length of 600 meters.

MINING OPERATIONS

An open stope and pillar system, with stull support in some places. The present workings are on the 150 meter level, taken along the dip. The mine is well equipped with modern machinery.

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METALLURGICAL OPERATIONS

The ore without any preliminary sorting is sent to the flotation mill and the concentrates further treated in Volkov autoclaves.

REMARKS

This sulphur deposit is well located in respect to export should this at any time become possible, as it offers cheap transport to markets near the Black Sea. Chekur Koyash was worked at various times before the revolution and was the first attempt of the Soviets to establish a sulphur industry.

The width and length of this deposit will limit its yearly production to not over 2,000 tons of sulphur. In 1934, 1,000 tons were produced and in the present year, this figure will not be exceeded to any large extent, (not over 1,500 tons).

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ARMENIA

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ARMENIA

The principal sulphur deposit in the Republic of Armenia is located 2½ kms. from station Sid-Ketantu or about one km. east of the Syagit Eriven district.

This sulphur occurs in the form of crystalline impregnations in gypsum bearing clays, in some places in nest-like form, up to 5 meters in thickness and 10 meters in lineal extent. A large quantity of H_2S gas makes exploitation difficult.

In addition to the above deposit, there is another small one near station Dallar on the Eriven-Tiflis railroad. The sulphur here also occurs in amorphous form.

There is no current production from either of these deposits and to date no plans have been made for their exploitation. With the construction of a large synthetic rubber plant at Eriven, these deposits will undoubtedly be utilized in the near future. Another source of consumption for this sulphur is as a fungicide or insecticide in the local vineyards.

The reserves are small and though relatively high grade their commercial possibilities of little consequence. Production will not exceed 500 tons yearly.

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MIDDLE ASIA

GADJINSKI
SHIRABAD-BAISUNSKI

BUKHARA PROVINCE

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BUKHARA PROVINCE

Much publicity has been given out from time to time in the Soviet press about the sulphur possibilities in this province, but with the exception of two of the deposits, little definite knowledge is available. The two principal districts are the Gadjinski and Shirabad-Baisunski.

GADJINSKI

LOCATION

In the Autonomous Republic of Karakalpack, approximately 100 kms. northwest of the city of Bukhara. This desert country is passable for an automobile.

DEPOSITS

Small denuded, anticlines (some 1½ kms. in length) which lie along a relatively flat, long anticline composed of Tertiary and Cretaceous rocks. The crest of the anticline has been eroded to the gypsum and limestone formations. The sulphur, finely crystalline, is found in the limestones and is associated with a brown to black soil, having a distinct bituminous odor. The thickness of the decomposed, soft ground which contains the sulphur, consisting of bituminous gypsum, kaolin, and inclusions of limestone, is 1 to 1½ meters. The average grade in this zone is 25 to 30% - in the limestone where it fills up cracks and cavities, from 4 to 15%.

This deposit has been prospected to a depth of 7 meters by means of small test pits. In the bottom of these pits strong H_2S gas was encountered.

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The reddish brown bituminous top soils are characteristic of the Tadjinski sulphur district. When wet, they form a sticky mass, without visible indications of sulphur. When dry, a thin film of sulphur is found coating the surface.

REMARKS

Very little has been planned for this deposit with the exception of additional exploration. The sulphur bearing limestone is of low grade and there appears little likelihood of exploitation at the present time. The 25 to 30% sulphur bearing top soil presents a metallurgical problem which has remained unsolved because of the sticky tendency of the ore when wet. Water is a serious problem as all the wells on this deposit are salt, and fresh water must come from Kurban-Ali or Tash-Kudak, 30 to 40 kms. away.

SHIRABAD BAISUNSKI DISTRICT

LOCATION

In Uzbekistan, close to the Afghanistan border.

DEPOSITS

Sulphur has been noted at several places in this district - the Kelif-Shirabad fold which is located along the left bank of the Shirabad river, north of the town of Shirabad; the Chakarlik-Astan fold which is located west of the Kelif-Shirabadski fold; and the Kazma Sai. Limited explorations by Geologists Laptieva, Michaelovsky, and Weber have recorded only general characteristics for these deposits.

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In general these districts are composed of rocks ofTertiary and Cretaceous age, folded into a series of anticlines of a north-east and south-west strike. These anticlines are followed from Amu-Daria through Kelif Kazma Sai and Sharalik-Astan. The sulphur is found in the gypsum formation which lies under the series of red and green colored Tertiary clays in some places. It is characteristic of this district that the gypsum and limestones are bituminous. Hydrogen sulphide springs and gas are general.

At Kazmai Sai the crystalline sulphur is found in calcite veins cutting the limestones of Upper Cretaceous age. The thickness of the sulphur zone is on an average 5 meters (varying 2 to 10 meters). It has an outcrop of some 400 meters. The reserves of possible ore (C-2) have been estimated at 500,000 tons by the Middle Asia Geological Prospecting Trust, the grade 5 to 10%.

REMARKS

There is not sufficient data on this district to support any accurate conclusions as to its future. Its remoteness, lack of water, and low grade are factors which will undoubtedly place it in a category for remote future use. Near this district are found the coals of Usuf-Darinski; Geriruda oil at Tir-puliak (west from Derata on Geriruda), and cupreous sandstones.

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PAKISTAN INSIGHTS

CA CASUS REGION

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The Daghestan sulphur deposits, west of the Caspian Sea in North Caucasia, can be divided into two groups according to their geographical location - 1. Deposits located along the Avarski-Koisu river and 2. Deposits near the town of Makhach Kala (formerly known as Petrovski).

AVARSKI GROUP

LOCATION

Consists of a series of outcrops or deposits extending in a northwest direction on both sides of the Avarski-Koisu river.

The Jurassic rocks composed of dolomites, marls, limestone and alabaster of varying thicknesses, outcrop along the Salatau range in the southern part of this district and the Gumrinski and Shrvat ranges in the northern part. The sulphur occurs in the clay beds, limestone and alabaster, as impregnations, pockets or veinlets and in general is found associated with gypsum.

DEPOSITS

Of the many in this region, the few deposits worth mentioning are:

KCHIUTSKI - Located 5 kms. northeast of the village of Chirkat or 30 kms. west of the town of Buinaksaka.

The sulphur accompanied by gypsum is found in pockets or as veinlets in a bed of dark blue compact clay which in turn lies between an alabaster bed 15 meters thick (forming the floor of the deposit) and a lower Cretaceous limestone bed, 40 meters in thickness, which forms the back. The sulphur bearing beds dip at an angle of 12 degrees to the northeast. The sulphur

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bearing portion of the bed has the form of a circular lense approximately 800 meters in diameter. The productive part of the bed varies from one-half to one and one-half meters on an average but in some places it attains a thickness of 4 meters. The average grade is 25% sulphur. The reserves are estimated at 80,000 tons of sulphur. The central portion of this deposit was worked out many years ago.

BALACH NSKI AND MOGOCHSKI DEPOSITS are located on the left bank of the Avarski-Koisu river about 30 kilometers southwest of the town of Temir-Chan-Shuri.

These two deposits are located on opposite flanks of the same anticlinal fold, the center of which has been eroded to form the Arata basin. The north flank of this fold forms the Enkit range and the south flank - the Mogochski range. Both deposits outcrop along the sides of the Arata basin.

MOGOCHSKI DEPOSIT is located on the north flank of the Mogochski range and is 1,580 meters above sea level. Here the denuded beds of limestone and alabaster have a thickness of only 4 meters and within these beds are found three interbedded layers of clay impregnated with sulphur. The lowest clay bed has a thickness of 0.75 meters; the middle bed, 0.2 meters: and the upper bed 0.1 meter. The sulphur is accompanied by large amounts of transparent gypsum. The beds dip to the southwest at an angle varying from 20 to 30 degrees and have been followed along the strike for a distance of 400 meters. Two inclined shafts are placed at the ends of this deposit. The sulphur averages 2% in the eastern sector and 16% in the western sector.

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Soviet geologists are now of the opinion that this area should be prospected along 3 kilometers of strike.

BALACHINSKI is located on the south flank of the Enkit range and about 2½ kms. south of the village of Balachinski. The outcrops of sulphur occur as disseminations in the middle part of the alabaster beds of the Enkit range. There are two sulphur bearing beds, each one meter in thickness, separated by a 4 meter layer of waste material. The deposit is but slightly prospected and is not considered of large extent.

GUMIRINSKI DEPOSIT is located 6 kms. southeast of the village of Gumirini or 30 kms. southwest of the town of Temir-Chan-Shuri on the northern flank of the Nagki-Meer peak. This deposit according to Soviet geologists has been slightly prospected, is not considered large, and its conditions in general are not favorable for exploitation.

MAKHACH KALA GROUP OF SULPHUR DEPOSITS

The sulphur in this group of "deposits" is found forming a thin coating on the clay and broken gypsum rock which form the alluvium of this district. The sulphur was thought to have come from extinct H_2S springs. Four "deposits" are known and all are located 14 kms. southwest of the town of Makhach-Kala along the Kugurt-Tau mountain range. The most important of these "deposits" are as follows:

KAPTAR KUTANSKI is located on the Kugutang plateau. The thickness of the alluvium (clay and gypsum rock) in this area varies from 1 to 3 meters. This alluvium is covered by a thin film of sulphur - in some places the amount is considerable. The area

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covers several hectares but was largely worked out in operation long ago.

QIIK SALAGANSKI is located on the north flank of the Kugurt-Tau mountain. The alluvium along this mountain attains a depth of several hundred meters, the sulphur-covered alluvium reaching a depth of 20 meters in some places. The sulphur is evenly though sparsely distributed throughout the alluvium - in some places in larger concentrations in pocket-like form.

KUGURT BASH - A small "deposit" in which sulphur is found in alluvium which has been more or less cemented. This "deposit" is of little importance.

REMARKS

The Daghestan deposits as a whole are poor and this is realized by the Soviets who are directing no great attention to them outside of cursory prospecting. The "deposits" in which the sulphur is found in the alluvium have little or no value, except as a matter of scientific interest.

The bedded deposits have more commercial value but their location along the precipitous mountain flanks makes transportation of ore difficult. In general, the pre-revolutionary operations extracted the best part of the ore and the poorer portions remaining can at no time become sulphur producers of any magnitude.

No work is at present contemplated on any of these Daghestan deposits, - should they be put in exploitation only small scale, costly operations can be conducted. The length of the deposits,

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the worked-out portions and difficulties of transportation will not permit the introduction of mechanization of mining to any extent. If ever revived, production from this district should not exceed 2,000 tons of sulphur annually.

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TADJIKISTAN

and

CASPIAN SEA

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TADJIKISTAN

While drilling for oil in the southern part of this province, a new sulphur deposit has been recently reported. According to preliminary information, it contains from 10 to 20 per cent sulphur and has a thickness of 1 meter. It lies 18 meters below the surface and its outcrop has been traced for a distance of several kilometers. Other deposits are reported by the Oil Geological Trust similar to the above.

In taking the numerous reported finds of sulphur by the Oil Trust into consideration, one must remember that the majority cannot be given much importance. In the first place, these deposits have a variable grade which makes it difficult to determine their commercial importance without more detailed prospecting. In addition, the oil trust in order to justify its dry holes is apt to report almost anything. Deposits of the above grade, thickness and depth below the surface are not commercial even under the elastic economic laws now prevailing in Soviet Russia.

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CASPIAN SEA

In this region sulphur indications have been reported from the following districts:

KARA-BUGAZ - In addition to the enormous deposits of Glaubers Salt, indications of sulphur have been reported in the district extending from the Sulamon farm through Kurgutli up to the Umchali Burun mountains. These sulphur deposits are small and of no commercial importance.

CHIVISLIAR DISTRICT, which lies along the eastern shore of the Caspian Sea above Persia, is one of mud mounds and springs which give off H2S gas. This district is of little commercial importance.

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KAMCHATKA

TRANSBAIKAL

SIBERIA

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SIBERIA

There are only two known districts in which native sulphur is found in the whole region from the Ural Mountains to the Pacific Ocean. These are as follows:

KAMCHATKA

Numerous outcrops of native sulphur deposits of solfatara type have been reported in the Kamchatka Peninsula in the Far Eastern Siberian region. The largest deposits are found near the cone of the Uzon Volcano near Crnotzki lake. These volcanoes are an extension of the Japanese volcanic range.

Little definite data is possible concerning these deposits although they are considered to be quite extensive and of fair value. Although the Soviets are directing more and more of their attention to the northern and far eastern Siberian republics, it is chiefly for gold, and no attempts have been made nor are planned to develop the sulphur deposits.

In the future it is conceivable that these deposits may enter the export sulphur trade to Australia and China as there will be little local demand for the material. The climate is severe and it has been difficult for even the Soviets to induce labor to work in the gold fields in this district.

TRANSBAIKAL

At the end of the 19th Century attempts were made to mine sulphur at the Ildenski mine which is located on the so-called "Sulphur" mountain in the Nerchinsk district in the Transbaikal Province in Siberia. The sulphur occurs as impregnations in limestone. The average sulphur content is considered by the Soviets as 5%.

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No plans have been made to exploit these deposits and as there is practically no demand in this region and the grade of the deposits poor, it is probable that the Ildenski deposit will remain idle for a long time to come.

RESERVES

The Soviet estimate, purely conjectural, for the metallic sulphur reserves for the entire Siberian region is 10,000,000 tons.

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SUMMARY

NATIVE SULPHUR DEPOSITS

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SUMMARY - NATIVE SULPHUR DEPOSITS

The native sulphur deposits are, in general, of poor grade, their mining problems difficult, their location remote, and in all cases they will be high cost producers. The sulphur occurs as thin seams or as impregnations in gypsum, limestone or sandstone, spotty in character. No domes of the Texas type have been found up to the present time although reports from time to time suggest the possibility that such domes may lie at depth in some districts. These reports represent "hopes" rather than facts. In all cases, the native sulphur deposits lie near the surface; and it remains for future oil drilling in the Middle Asia district - aggressively under way - to disclose domes, a type of deposit for which the Soviets are constantly looking.

The Soviet figures on reserves are in many cases not warranted, as pointed out in this report, and the grades of ore are probably far from accurate due to the spotty nature of the sulphur in the deposits. From all known data, the grade in general (exception, Kara Kum) will prove fairly low.

The Planned Capacities of the various native sulphur plants appear to the writer to be entirely too high. The Table, showing maximum annual tonnages possible under optimum conditions, indicates little prospect of Soviet Russia becoming a trade menace as far as native sulphur deposits are concerned. In fact, unless they were protected by high tariffs or by governmental regulation of imports, these deposits could not survive, under current competitive conditions of the industry abroad.

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~~The Soviet plans for making sulphuric acid from anhydrite and gypsum are purely paper plans for some far-off period.~~

The Alexiev and Vodina deposits in the Middle Volga region, and the Gaurdak deposit in the Turkmen republic that borders the Caspian Sea on the east, have probably the greatest commercial possibilities. Although of low grade, they have large area and potential production, and the Volga deposits enjoy good geographical location in respect to transportation. A large demand for sulphur exists in the Middle Volga industrial district but this demand can be supplied by the Ural pyritic deposits which conceivably may release production at Alexiev and Vodina for export trade. The Gaurdak deposit, although unfavorably located, is of large probable reserve, and is important because of the potassium salts accompanying the sulphur. These salts are to be exploited by the Soviets, and this sulphur deposit will have more or less vigorous parallel development. The local demand for sulphuric acid in Middle Asia will be supplied by the metallurgical plants at Kounrad, Chimkent, Dzheskazgan, all of which are designed to recover sulphuric acid. This should release this Gaurdak production also for export in time to come.

The Kara Kum sulphur deposit, the highest grade in Russia, having fairly large reserves, is hampered by lack of water and transportation handicaps which will prove costly and difficult to overcome.

The Shor-Su deposit in Uzbekistan, now operating, has somewhat exaggerated repute in Soviet plans of future output but its

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production should nevertheless be substantial and not required for local demands which can be satisfied by the Middle Asia metallurgical plants.

The Chekur-Koyash deposit in Crimea is small but as there is a plant in operation there at the present time, it is expected that this deposit will continue to be exploited although the coal pyrites of the Don region should be more than sufficient to satisfy local consumption. This will undoubtedly release this production for other than local consumption.

The Armenian and Trans Caucasus deposits are small and will have little or no future importance. The metallurgical plants at Allaverdi, Zangezour and Ordjonikidzie, and the pyrite deposits in this region will be more than sufficient to meet the local agricultural and industrial demands.

Sulphur deposits in the Caspian Sea region, Daghestan, Tadjikistan and Bukhara are of little present or future commercial importance. They are of low grade, and the difficulties of transportation, water supply, etc. practically prohibit their exploitation at the present time.

In Siberia, the Transbaikal deposit has little importance although the Kamchatka deposits, if exploited, may have some bearing on the Asiatic and Australian markets.

The widely scattered surface findings of sulphur in the Middle Asia region in a belt some 300 miles wide, paralleling the entire southern border of the U.S.S.R. north of Persia and Afghanistan, have led certain inexperienced and enthusiastic Soviet geologists to incline toward overstatement of the reserves of sulphur in,

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and the importance of, this district. They have connected all these points in thought, and have become convinced that these areas indicate a tremendous commercial sulphur possibility. The actual characteristics of the principal deposits, as shown in this report, place a distinct limitation on the commercial picture as far as the native deposits are involved.

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II
PYRITES SECTION

"Soviet Russian Sulphur"

Ural Pyrites (Copper and Iron)
Copper and Pyrite Deposits Other Than Urals
Conclusions

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INTRODUCTION TO URAL PYRITE DEPOSITS

The Ural Mountains dividing European Russia and Siberia dominate a region that is considered by the Soviets the most important industrial section of the U.S.S.R. Its geographic position in the central part of the Union, location well back from the frontiers, and its varied mineral resources made this section the first to receive intensive industrialization at the hands of the new Government. A great inland industrial empire has sprung up here during the past ten years - steel, copper, power, coal and machinery plants.

The copper industry in this region is the most highly developed of the several Soviet copper districts. Five years ago, but one small flotation mill of 250 tons capacity was in operation, today, there are four mills operating with a total daily capacity of 6,200 tons; five more under construction. The Ural copper accounts for approximately 75% of the Soviet total production (estimated in 1935, 70,000 - 75,000 tons) and this comes entirely from copper-zinc-gold pyritic deposits.

Formerly the pyritic material for the Soviet sulphuric acid plants came from Ural run of mine ore with a copper content less than 1.5% or from deposits considered purely "sulphur" pyrite. With the advent of flotation mills, the Government decreed that all ore with a copper content over one-half of one percent must be considered as copper ore and treated as such, but to mine at the same time all ore for its sulphur regardless of the copper content.

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During the past two years, the Soviets have become "sulphur" conscious" in regard to this Urals source of potential sulphur both in elementary form or for sulphuric acid. Large sums have been allotted for experimental work. Flotation mills are incorporating in their design additional flotation machines for re-floating the copper tailings to increase their 35 to 42% sulphur content to 48%. Driers have been constructed at various points and the sulphur gases from the roasters are to be utilized for sulphuric acid manufacture.

Two major economic objectives of the Soviets, - first to make Russia "free from foreign imports" and second, to use all by-products at any cost, - give these flotation tailings a peculiar importance. This importance is evident in all districts; I have, therefore, in the immediately following pages, for this and other reasons bearing on the sulphur industry, set forth the essential characteristics of all the pyrite districts, their possibilities, sulphur plans, sulphur production and experiments now going on to utilize the flotation mill tailings.

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9

GEOLOGY IN GENERAL

Briefly, in geological aspect, the Ural pyrite deposits have the following characteristics:

The main pyrite deposits are found largely along the eastern flank of the Urals, although deposits are also found along the western as at Baimak and Blaiva. The rocks composing the eastern side are Devonian sediments (slates, schist, limestone) associated with metamorphic lavas, intrusive igneous rocks (gabbro, diabase, serpentine, diorite) and large areas of pre-Cambrian granite and gneissic rocks. The copper pyrite deposits were formed subsequent to the last regional metamorphism through metasomatic replacement of the schist, and consist chiefly of lenses conforming in dip and strike with the inclosing schist. In general, they have a north and south strike with a dip to the east and pitch to the north.

These lenses range in length from 50 to 4,200 meters and in depth from several hundred meters (the roots of once deep lenses) to those 1,000 meters or more, as in the Karabash district. The ore is principally iron pyrite, chalcopyrite, tennanite, zinc blende, galena, silver and gold, - copper ranging 1.00 to 2.25%, but reaching as high as 25% in some of the smaller deposits, and the zinc running up to 17%. The gold value of the ores varies from 1 to 20 dollars. (.35.00 p. oz.)

Zones of pyritic ore low in copper but high in sulphur are found in all deposits. These usually are found along the hanging walls or immediately under the gossan.

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DEGTIARKA
(formerly Sissert Estate)

URALS

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DEGTIARKA

LOCATION

This mine under the management of Sreduralmedstroy (Middle Ural Copper Trust) is located at Degtiarka, a small village, 18 kilometers from Revda, a station on the Perm-Moscow-Sverdlovsk railroad line. It was a part of the old Sissert Estate before the Revolution, and more recently part of the Lena Goldfields Concession. The mill and the smelter have been placed at Revda as there is a better water supply at this point and are connected to the mine by a broad gauge railroad under the management of the Copper Trust. The region over which this trust exercises control lies between the 56 deg. 10 mins. and 57 deg. North Latitudes.

DEPOSIT

The largest copper pyrite occurrence known in Russia, length 4,200 meters, width from 1 to 50 meters (average 12). The dip is to the east and is not regular, varying from 40 to 90 degrees. The orebody is relatively narrow in its northern part and wide in the south central portion. In depth the width is subject to considerable variation, there being a series of swellings and constrictions.

The deposit, dipping under a low wooded hill, is covered by a gossan of no value. Below this gossan is a zone 30 to 50 meters in depth, consisting of a sand-like pyrite which has resulted from the leaching action of the ground water. The sulphur content of this zone has been somewhat enriched by the washing action of the water but on the other hand the copper content has been impoverished. Under this zone, massive sulphides of iron, copper and

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92 zinc occur. The schist hanging wall with disseminated pyrite as well as massive sulphides is well fractured, due to post mineral compression.

MINING

The past and present mining operations have been confined to a 1,000 meter stretch along the south central portion on the 42 and 69 meter levels. The system used was square set and fill. For a distance of 300 meters in the northern section, an open pit was used to mine "sulphur" pyrite which was shipped to the chemical plants in the south for sulphur content only. At present, work in this open pit has been stopped due to excessive amount of overburden to be removed. The ore from the south-central section is hoisted through four shafts - the London; the Moscow; the New York and the Berlin. The ore from the New York and Berlin shafts is sent to the chemical plant and is to be considered sulphur ore until such time as the massive sulphides are reached in lower workings.

The Soviet plans call for the mining by 1957 of 4,500,000 tons of ore yearly from this deposit, a figure impossible of attainment should a square set and fill system be used. American engineers have, accordingly, recommended a change to top slicing and sub-level caving which methods, though dangerous from the fire hazard angle, will be tried.

The four above shafts are to be abandoned as soon as active caving begins and two circular shafts of concrete construction, located 1,000 meters apart, will replace them. The sinking of these concrete shafts is slowly progressing (the North shaft

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down 87 meters, the South 151 meters (July 1935) but as this amount of sinking represents a period of two years, four months work, it looks as though they will not be ready for operation much before 1937. It is planned that both these shafts shall reach the 810 meter level before they can be placed in operation.

While a total of 17,000 meters of development work is necessary before the planned tonnage can be attained, the level development, raises, sublevels, etc. are progressing but slowly, especially in the northern section. The development and operation of this mine from 2 shafts only will present serious future difficulties. It is extremely probable, moreover, that, as in the southwestern part of the United States, a caving system (top slicing and sublevel caving) applied to these Ural pyritic deposits will lead to disastrous mine fires.

Several of these Ural mines are now under development for the application of sublevel caving and top slicing and this fire hazard may, I believe, play an important part in future copper, iron and sulphur production. At the Third International group of mines, near Nijni Tagil, where this system has been in use for less than a year, it was noted during a recent inspection trip through the mine that temperatures ranging from 90 to 100 degrees prevailed immediately under the timber mat or working level. According to Mr. Banketov, the Manager of this group of mines, a small fire had occurred just prior to this inspection visit. As caving progresses in depth and the timber mat increases the fire hazard will increase. Three mine fires are now burning in Ural districts, due to caving of old square sets - Krasno Gvardeiski in the Krasno Uralski district; the Stalinski mine

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in the Karabash district: and the Kalata mine in the Kalata district.

PLANS

The mine, mill and smelter have been designed for an annual capacity of 4,500,000 tons of pyrite ore. Construction of the mill and smelter at Revda is progressing slowly but a unit of 5,000 tons should be in operation during 1936.

RESERVES

The following table shows the reserves of this district:

Category	Tons	% Copper	Tons Copper	% Sulphur
	Copper pyrite ore			
A+B+C-1	66,512,000	1.49	988,900	46.41
C-2	26,811,000	1.30	348,800	46.41
	93,323,000 *		1,337,700	
	"Sulphur" pyrite ore (for sulphur only)			
A+B+C-1	19,274,000	0.30		46.41
C-2	14,882,000	0.30		46.41
	34,156,000 *			

*These figures include the considerable recent increases in prospected reserves.

The orebody has been prospected to a depth of 150 meters by 84 drill holes, and in the central portion by several drill holes to a depth of 400 meters.

METALLURGICAL TREATMENT

Degtiarka ore will be transported by rail to Revda, 18 kms. distant. The mill and smelter is under construction at the present time. The ore will be floated for copper concentrate and the tailings will pass through other flotation machines for increasing the sulphur content for subsequent treatment in the chemical end of this trust. The copper smelter is to handle

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50,000 tons of copper yearly and the mill 4,500,000 tons of pyrite ore, (by Soviet Plan).

SULPHUR TREATMENT PLANS

The tailings from the re-flotation treatment are to be used either in the manufacture of sulphuric acid or for elementary sulphur. Two plans have been made but which plan is to be adopted has not been decided on due to the poor results obtained to date by Prof. Ushkevich's experiments with flash roasting at Kalata. One "plan" is to produce 500,000 tons -(sic., Benoni, Chief Engineer Urals Projecting Trust 1934) of elementary sulphur, the remainder of the pyrites being utilized for sulphuric acid manufacture. The alternate plan is to produce 80,000 tons of elementary sulphur, the remainder also being utilized for sulphuric acid. It is to be noted that all the pyrite tailings will be utilized in either plan.

The copper concentrates will be sent to the smelter, which has been designed to utilize the gases therefrom for sulphuric acid manufacture.

POSSIBLE PRODUCTION

As there is a movement in Russia now to investigate the fire hazard in the use of top slicing and sub level caving systems as applied to pyritic deposits, the following tonnage figures have been based on the application of a square set system in the personal conviction that this is the only mining system that can be continuously used in these deposits.

This system should, under the best conditions, permit the mine to reach the maximum tonnage of 1,500,000 tons yearly, (instead of 4,500,000). Assuming an 11 to 1 concentration in the

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mill, which appears to be the working average of all operating mills in the Urals, approximately 136,000 tons of concentrates will be sent to the smelter yearly. The Soviet Plan as it stands calls for 40,000 tons of sulphuric acid from the smelter gases on basis of 4,500,000 tons; 15,000 tons acid on the reduced tonnage to be mined in my opinion.

The 1,364,000 tons of tailings will pass through the re-flotation unit and will be concentrated to approximately 43% sulphur content. Assuming a mill recovery of 75% and a concentration from 40% (original feed) a total of 552,500 tons of tailings of average grade of sulphur 43% should be available for further treatment.

According to Lenander 80% of the sulphur can be recovered as elementary sulphur. Under one plan the production of 550,000 tons of sulphur would require more tonnage than is available. If all tailings (1,364,000 tons) were to be utilized for elementary sulphur then approximately 317,260 tons (.80 x .40 x 1,364,000) are possible under the reduced tonnage. In the other plan 30,000 tons of elementary sulphur would be produced and the remainder used for sulphuric acid manufacture.

Remarks

The Soviets, in their plans, appraise the importance of this great Degtiarka deposit as to gold, copper and iron values, in the ratio of Chemical 70%; Copper 20, Iron 10, - indicating that they intend to get set for maximum utilization of sulphur from these pyrite deposits.

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The district is well located in respect to transportation, fuel, labor, etc. It is near Sverdlovsk, the Capital of the Ural region and the center of industrial activity.

The Mine Manager at Degtiarka, Mr. N. Novikov, appears to be incapable of handling a large mine like this. The organization is not the best and the work clearly shows this.

The Manager of the Mill and Smelter at Revda, Mr. A. Guncherov, is a graduate of Leningrad Institute before the revolution and is a very capable engineer. Due to a previous jail sentence for alleged counter revolutionary activities, his initiative is kept somewhat well curbed.

The mill and smelter will be completed in advance of mining operations and it is impossible to conceive that the mine will for any length of time be able to supply the mill with the 14,000 tons of ore daily called for by the Soviet 4,500,000 ton plan.

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KALATA DISTRICT

URALS

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KALATA DISTRICT

LOCATION

Lies to the south of the Krasnouralski district and north of Sverdlovsk. Kalata (the smelter and mill site) is connected with Shurala, a station, on the Perm-Moscow-Sverdlovsk R.R. by a wide gauge railroad. All deposits within this district are connected with the smelter by a narrow gauge railroad.

DEPOSITS

Two zones of mineralization are found in this district, separated from each other by granite intrusives, - in the west zone, the Levika Group and Karpuschinski; in the east, the Kalata, Oblavenski, Bellorechinski and Shaitanski deposits.

Levika Group - consisting of 12 separate lenses, lies along the Levika river, a left tributary of the Tagil, about 32 kms. northwest of the smelter at Kalata. Augite dikes cut the quartz sericite schist - in some cases forming the hanging walls. These lenses vary in length from 50 to 100 meters and in width from 5 to 30 meters. Copper minerals predominate in some deposits as in Levika Nos. 1,9,11 and copper-zinc minerals in Levika Nos. 2,3, and 12, - all others are largely "sulphur" pyrite.

Drill holes at a depth of 150 meters in all these deposits offer conclusive evidence of pinching out, but a disseminated pyrite zone some 2,000 meters in length and varying from 4 to 20 meters in width, not yet drilled in depth, is believed by local geologists to contain massive copper-zinc lenses.

Karpuschinski deposit is located south of the Levika group and consists of two lenses - the West and East. The West is purely

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"sulphur" pyrite, the East is polymetallic. On the 120 meter level - the present operating level - the lenses have undergone a large reduction in cross sectional area from that in the upper levels.

Kalata Group near which is the old operating smelter, consists of a series of lenses. Four lenses have been found at depths varying from 10 to 250 meters below the surface and a fifth at 300 meters. The average length of each lense is 150 meters and the width 20 meters. At 300 meters in depth or that point at which the fifth lens appears, the upper four lenses have practically disappeared. The copper ore largely occurs along the footwall, the remainder of the orebodies being sulphur pyrite. In depth the copper content shows an appreciable decrease from that found in the upper lenses.

Oblavenski Group is located south of Kalata and consists of a series of parallel lenses with a total width of 20 meters. The length of each lens is approximately 200 meters. Copper pyrite is found only in the southern portions of these lenses, sulphur pyrite in the northern portions. Drill holes at a depth of 160 meters show the disappearance of the orebodies.

Bellorechinski Group, located 12 kms. south of Kalata, consists of two lenses which unite at a depth of 75 meters below the surface. The west lens has a length of 65 meters, width 10 meters, while the east lense is 110 meters in length, width 8 meters. The deposit has been prospected to a depth of 200 meters.

Shaitanski Group found between Levika and Kalata deposits consists of a series of small lenses ranging from 50 to 100 meters in

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length. Drill holes show that these lenses have practically pinched out at a depth of 150 meters.

Other deposits - in addition to the above deposits, electrical prospecting has pointed out a mineralized zone - the Iurevski - about 10 kms. north of the Levika Group and a large disseminated pyritic zone near the Karpuschinski deposit.

MINING OPERATIONS

Some of these mines have been worked for over a hundred years; the first mining being confined to the iron ores found in the gossan. Until recently, the Kalata, Oblavenski and the Levika No. 9 mines have been worked by open cut but have changed now to underground methods. With the exception of the narrow lenses found in the Levika group - in which shrinkage stoping is used - all mines in this district use the square set and fill method. The Kalata and the Oblavenski mines have been on fire for many years - the former the more serious one - and despite numerous attempts to extinguish, the fires still present a serious menace to life and property. In both these mines complete shutdowns are experienced at intervals, usually following the death of miners due to the gases caused by the fires.

POSSIBLE PRODUCTION

In the future, as all these mines in depth show a large reduction in cross sectional area or rather definite signs of pinching out, production will tend to fall off with each succeeding year. With a square set and fill, and shrinkage stoping, as the mining systems to be used here, the maximum possible annual production

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from this district should not exceed the following figures:

Name of Group	Copper Pyrite Yearly Production	Sulphur Pyrite (Tons Ore)
Oblavenski	40,000	
Levika	50,000	250,000
Shaitanski	20,000	
Kalata	100,000	
Karpuschinski	50,000	25,000
Bellorechinski	100,000	25,000
Totals	360,000	300,000

The "sulphur" pyrite figures above are purely estimate. No plans are being made to mine the sulphur ore in a deposit like Levika No. 10, which is considered purely sulphur pyrite. In all mines in which sulphur pyrite is found as a part of the ore-body itself the mining of this grade of ore will be done simultaneously with that of the copper ore. This district in normal operation should produce 75,000 tons of sulphur pyrite ore for shipment to the sulphuric acid plants in the south.

RESERVES

The following reserves are given for this district - Soviet Geologists:

Copper Pyrite Ore

Name of Mine	Category A,B,C-1 Tons	Cu.%	Category C-2 Tons	Cu.%	Total
Levika IX	42,300	11.16	-	-	42,300
" II	35,000	4.92	-	-	35,000
" I & XI	149,800	7.41	-	-	149,800
" III	6,000	7.69	-	-	6,000
" IV	2,400	5.31	-	-	2,400
" XI	162,400	6.68	-	-	162,400
Karpuschinski	392,000	3.99	-	-	392,000
Kalata	1,096,000	1.49	610,000	1.00	1,706,000
Oblavenski	327,000	1.19	69,000	0.87	396,000
Shaitanski	136,000	1.31	-	-	136,000
Bellorechenski #1	650,000	13.00	350,000	6.67	1,000,000
#2	294,000	5.0	30,000	0.60	324,000
TOTALS	3,292,900		1,059,000		4,351,900

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Sulphur Pyrite Ore

Name of Mine	Category A,B,C-1	C-2	Total
Levika VII & VIII	550,000	800,000	1,350,000
" VI & IX	7,180,000	370,000	7,550,000
" IV & XII	1,013,000	125,000	1,138,000
" I & XI	3,412,000	882,000	4,294,000
Karpuschinski	-	20,000	20,000
TOTALS	12,155,000	2,197,000	14,352,000
Sulphur Pyrite	12,155,000	2,197,000	14,352,000
Copper Pyrite	3,292,900	1,059,000	4,351,900
	15,447,900	3,256,000	18,703,900

METALLURGICAL OPERATIONS

At the present time a smelter consisting of three 400 ton blast furnaces, and a roaster and reverberatory plant are in operation at Kalata. The blast furnaces handle the high grade ore shipped from San Donato district, the Levika Mines, and the Bellorechinski mines in the Kalata District.

A flotation mill of 750 tons capacity has been in operation here since 1931 and is in need of repairs. The low grade ores mined in the Kalata, Shaitanski and other mines are sent to the mill.

The gases from the regular roasters and from the blast furnace are utilized for sulphuric acid manufacture by the Peterson Tower method. The cost per ton of sulphuric acid is the highest in the Soviet Union here - averaging approximately 160 rubles per ton. (See comment on ruble valuation, under Sulphur Experimental Plant, Krasno Uralsk).

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SULPHUR PLANT

The sulphur plant layout at Kalata is practically the same as that on which we reported some time ago.* Some recent minor changes have been made which have increased the overall efficiency of the plant and eliminated many of the former objectionable features. These changes are pointed out in the following description.

Dried flotation mill tailings are flash roasted in a furnace known locally as the "Ushkevich." This furnace is a cylindrical, brick lined shaft divided into two sections. Although the original "Ushkevich" furnace was rectangular in design and is still in use at Perm, and Polevski, it will be replaced by furnaces of cylindrical design. In the rectangular design, slag accummulated in the corners.

Formerly the tailings from the flotation mill were filtered and sent directly to the driers (filters) in the sulphur plant. At the present time, these filters have been eliminated and the tailing-pond divided into sections by means of earthwork walls which permits draining of the water from the tailings to a higher degree than formerly possible with the filters. After the tailings have been drained for a period of months, it is found that the upper portion in these sections may be used without drying.

The tailings from the pond are now elevated to the bunker by means of a pneumatic conveyor instead of by the old bucket elevator.

These minor changes up to this point have eliminated many of the objectionable features of the old plant and have reduced the dust hazard to a minimum.

* April 4, 1935, to Mr. C.A. Snider, Sulphur Export Corporation.

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Some trouble is still experienced with the screw conveyor which feeds the pyrite tailings to the furnace. The trouble is not in the application of the screw conveyor, which has a variable speed, but in the materials which make it up. These wear out rapidly but experiments are constantly being made to improve this apparatus, the cause of much delay, and trouble.

The fans which supplied the primary and secondary air were found unfit for the work required of them. These have been replaced by higher pressure fans, and with small changes in the type of pyrite feed nozzles much better results have been obtained in the roasting of the pyrite tailings. Formerly the content of sulphur in the slag was found to be as high as 12% but now it varies from 1 to 2%.

The two old Ushkevich furnaces at Kalata are still equipped each with three electrostatic filters, catalysts, and gas producers. This triplication of equipment was made necessary due to the excessive amount of dust flowing throughout the system as the dust collectors and electrostatic filters were found to be too small. The new 50 ton furnace recently installed and in operation has avoided this triplication of equipment. A larger unit is used, thus simplifying operations to a considerable extent and permitting better plant control.

The plant has a capacity of 150 tons of pyrite tailings daily but this figure is seldom attained due to the troubles experienced in the old units. Plans have been made to replace these old units as soon as possible and to add another 4th furnace.

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REMARKS

The Soviet engineers readily agree that the production cost per ton of elementary sulphur is high with this method but consider this trivial in comparison with the vital necessity of obtaining a sufficient supply. A Ural supply of sulphur is regarded as especially desirable by the Government because of central location.

More objections have been raised to the dust hazards and sulphur content in the slag than the costs. At the same time they frankly admit that the plant is a direct infringement of the Freeman patent of flash roasting but they say as long as the sulphur is used within the country, they believe that little can be done about it.

One thing which finds favor with the Soviet officials is that these Ushkevich plants do not require foreign equipment and can be constructed entirely of Soviet materials.

This plant in 1934 turned out 7,500 tons of sulphur and in 1935 with the new furnace in operation as well as the improvements pointed out, having been made, the production of elementary sulphur is expected to exceed 12,000 tons.

As nearly as we can ascertain, from several individual sources, the recovery at these Ushkevich plants (Kalata, Perm, Polevski) has been about 30 to 40% to date, as compared with the 80% objective.

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SCHEME OF OLD SULPHUR PLANT LAYOUT

(See diagram sketch accompanying Prelim. Report to Mr. C.A. Snider, of April 4, 1935)

FLOTATION MILL

↓

FILTERS

↓

DRIERS

↓

BUCKET ELEVATORS

↓

BUNKER

↓

SCREW CONVEYOR

↓

FLASH ROASTING FURNACE

↓

DUST COLLECTOR

↓

8 HIGH TEMPERATURE PRECIPITATORS IN SERIES

↓

HIGH PRESSURE BOOSTER FAN

↓

THREE GAS PRODUCERS IN PARALLEL

↓

THREE CATALYST CHAMBERS IN SERIES (BAUXITE)

↓

CONDENSER

↓

LOWER TEMPERATURE PRECIPITATOR

↓

TWO CATALYST CHAMBERS IN PARALLEL (BAUXITE)

↓

CONDENSER

↓

LOW TEMPERATURE PRECIPITATOR

↓

STACK

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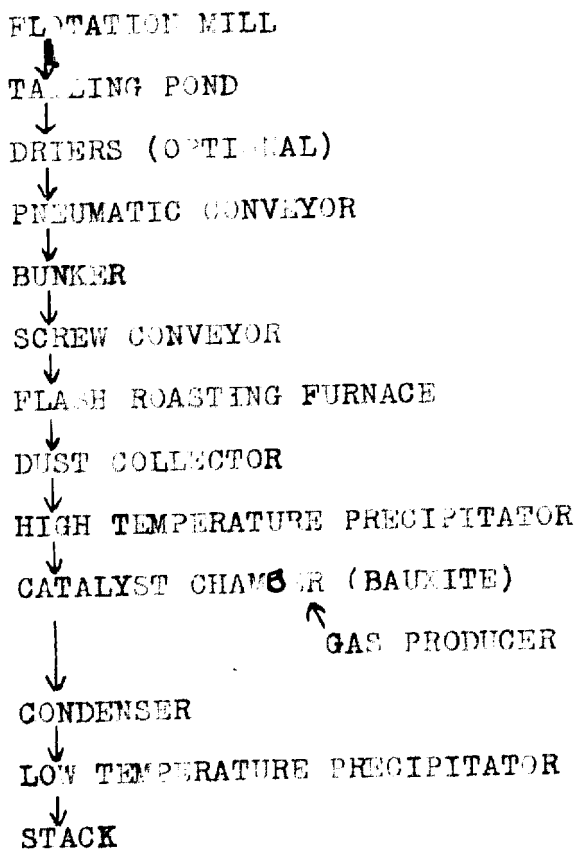
SCHEME OF NEW LAYOUT AT KALATA SULPHUR PLANT



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L109

KARABASH DISTRICT

(Formerly Kyshtim Estates)

URALS

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KARABASH DISTRICT

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LOCATION

In south central part of the Urals. The territory over which the Karabash Copper Trust exercises control (former Kyshtim Estates) lies between the 56 deg. 10 min. and 53 deg. North Latitudes. The copper mines are linked to Kyshtim, a station on the Moscow-Sverdlovsk-Cheliabinsk-Siberia railroad, by a narrow gauge railroad.

DEPOSITS

There are eight known copper-zinc-gold pyrite deposits in this district: four in active exploitation, one under development. They are all massive pyritic orebodies with varying contents of copper, zinc, and sulphur. They strike north and south and dip to the east. The operating deposits are as follows:

Voroshilovski - (formerly Smironoff), located four kms. north of the smelter, has two parallel lenses. The west lens has a length of 575 meters, with average width 5 meters. The copper pyrite ore (2.5 to 4.0% Cu.) is found only along the northern section for a distance of 250 meters, the remaining 325 meters being "sulphur" pyrite, untouched by mining. The East lens is 105 meters in length on the lower levels with an average width of 3 meters.

Dzerdiinski (Koninoff in pre-revolutionary days) located one km. north of the Voroshilovski mine, has a length of 300 meters, and dips to the east at an angle of 65 degrees. In depth it breaks into a series of small lenses which gradually change into disseminated

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ore. The south end of this deposit is mined for its sulphur: the central and northern sections are high in copper, gold and zinc. Grade average, 3.0% Cu., 3.0% Zn.

Pervomaiski (former Americanski) located 3 kms. south of the smelter, is 200 meters in length with an average widthof 4 meters, has a north and south strike and dips to the east at an angle of 60 degrees in the upper levels, 40 degrees in the lower. A diamond drill hole did not undercut the orebody at a depth of 650 meters but Soviet geologists believe that the orebody changed dip and pitch and did not pinch out. Average grade 4.0% Cu. 2.0% Zn.

Stalinski (Tissoff. of old) 2 kms. south of the Pervomaiski mine, has a length of 330 meters with an average width of 8. The lens is composed of intermingling layers of copper and "sulphur" pyrite divided by narrow zones of quartz sericite schist well disseminated. The higher grade pyrite ore is found along the footwall. There is very little zinc; copper content about 2.0%. The South part, as well as the North part of the deposit except for a narrow (12 ft.) vein of copper ore on 340 ft. level, is principally iron pyrite and the mine is worked mainly for its sulphur.

Pioneerski (Ivanoff), 2½ Kms. south of the Stalinski mine, has two lenses (about 1.0% Cu.), East and West, which are divided by a zone of quartz sericite schist 30 meters in thickness. Both lenses dip to the east at an angle varying from 70 to 80 degrees. The east lens has a width varying from 0.3 to 3 meters and a length of 80 meters, the west, a length of 90 meters and an

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average width of 2.

North Pervomaiski, located one km. north of the Pervomaiski mine, has a length of 200 meters and an average width of one meter. The copper contents are poor, about 2.0%; zinc about 8.4%.

South Kuznechinski, one km. east of Kuznechinski, a station on the Sverdlovsk-Moscow-Siberia railroad line, has a length of 1,200 meters and average width of 3½. The orebody is composed of zinc-copper pyrite and "sulphur" pyrite intermingled with zones of pyrite dissemination. The massive sulphides are irregular along the strike and along the depth; grade 1.6% Cu, 13.0% Zn.

North Kuznechinski, located 8 kms. north of South Kuznechinski deposit, has a length of 1,150 meters and varies in width from 0.1 to 2 meters. It is relatively high in gold and silver values, averaging 7 grms. and 27 grms. respectively.

MINING

The operating mines are as follows: the Voroshilovski, and Dzerdjinski, comprising the north group of mines. Both are operated through two incline shafts and one vertical shaft which is the main ore shaft. The 7th and 8th levels of the Voroshilovski mine have been worked out. The 9th and 10th are in operation with the 11th under development. The Dzerdjinski mine is working the 8th and 9th levels.

In both mines a square set system of mining, with fill, is used. In the narrow parts incline cut and fill is used. Shrinkage stoping was introduced in the Voroshilovski in an attempt to cheapen the mining method but on account of excessive dilution from the walls has been discarded. Production from the Voroshilovski mine for the past five years has varied from 150,000 to 250,000 tons

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annually. The Dzerdjinski mine for the same length of time has a production between 85,000 to 150,000 tons.

The Stalinski and Pervomaiski mines are the operating units comprising the South group of mines. The Stalinski mine in pre- and-post-revolutionary times was a constant producer of "sulphur" pyrite ore which was shipped to the chemical plants in southern Russia. It is operated through a vertical shaft located near the old open cast workings. The lowest working level is the 8th. At present the mine is shut down because of a fire in the old workings. The system of mining is close timbering and fill, or rather the "cross cut method." Its normal annual production varied from 75,000 to 150,000 tons.

The Pervomaiski mine is operated through a vertical shaft which intersects the orebody at the 5th level. Due to pillar robbing operations in the past, the upper part of this shaft has settled. It is necessary to sink a new shaft in order to increase production. The system of mining used at this mine is square set and fill: shrinkage stoping failed due to dilution and the flat dip of the orebody.

The North Pervomaiski mine is under development. The Kuznechinski mines are operated for the gold and silver ore in the oxidized zone. All other mines are kept in reserve.

METALLURGICAL OPERATIONS

A 2,000 ton unit of a 4,000 ton flotation plant is in operation. Its flow sheet has been designed for re-flotation of the tailings in order to increase the sulphur content. The mill concentrate is roasted and sent to the reverberatory plant for

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smelting. In addition, there are three blast furnaces in operation. Two of these furnaces are of 400 tons daily capacity each, and one is 600.

SULPHUR PLANS

The sulphur gases from the roasting plant are to be utilized locally for acid manufacture. Although the tailings have been treated to increase their sulphur content, no arrangements have been made to use these locally. The present plan is to dry the tailings to 3 per cent and ship them to the sulphuric acid plants now in operation in the south of Russia. This plan has been made necessary due to the local use of pyrite tailings at Degtiarka and Krasnoe Uralsk thus making a shortage of pyrite materials in the existing southern sulphuric plants. Only one blast furnace plant in the Urals will be used to any extent and that is the Kalata. Flotation mills and reverberatory plants will replace all other existing blast furnace installations.

POSSIBLE PRODUCTION

Taking into consideration the length, width, method of mining, development, physical characteristics and increasing difficulties due to mining in depth, the following tonnages represent our estimate of the maximum that can be mined daily. As these orebodies show a marked tendency to decrease both in length and in width, it will be more and more difficult to keep up production as mining progresses in depth.

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Voroshilovski Mine	1,000	tons
Dzerzinski Mine	700	"
Pervomaiski Mine	500	"
North Pervomaiski Mine	250	"
Stalinski Mine	750	"
Total	3,200	tons daily
	or 970,000	tons yearly

With a mill concentration of about 11 to 1, 88,200 tons of concentrates will be roasted yearly. This should give approximately 9,000 tons of sulphuric acid.

The remaining 882,000 tons of tailings are to be re-floated to increase the sulphur content. The average grade of sulphur to the mill will average 36 per cent due to the mining of low grade disseminations. With a mill recovery of 75 per cent and an ultimate concentration to 48 per cent sulphur, approximately 496,000 tons of tailings of 48 per cent sulphur will be available for shipment to the southern sulphuric acid plants.

RESERVES

Reserves, as follows, have been divided into copper pyrite ore and "sulphur" pyrite ore.

(See next page)

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NAME OF MINE	CATEGORY	TONS ORE	SULPHUR	PROSPECTED
COPPER PYRITE ORE				
Vorshilovski	A B C-1	3,733,000	38.4%	500 met.
	C-2	772,000	33.	
		4,505,000		
Pervomaiski	A B C-1	1,060,000	43.1	650
	C-2	280,000	38.0	
		1,340,000		
Stalinski	A B C-1	1,449,000	45.3	500
	C-2	405,000	40.0	
		1,854,000		
Dzerinski	A B C-1	1,000,000	42.1	680
	C-2	1,700,000	36.	
		2,700,000		
Pioneerski	A B C-1	155,000	44.0	150
	C-2	30,000	35.0	
		185,000		
Kuznechinski	A B C-1	454,000	42.5	150
	C-2	95,000	34.	
		549,000		
North Pervomaiski	A B C-1	209,000	45.1	
	C-2	34,000	38.	
		243,000		
TOTAL	A B C-1	8,060,000		
	C-2	3,316,000		
		11,376,000	Tons Copper Pyrite	
"SULPHUR" PYRITE ORE				
Stalinski	A B C-1	1,205,000	46.1	
	C-2	647,000	42.	
		1,852,000		
Vorshilovski	A B C-1	1,636,000	45.1	
	C-2	504,000	41.	
		2,140,000		
Pioneerski	A B C-1	35,000	44.8	
	C-2	-		
		35,000		
Kuznechinski	A B C-1	221,000	44.5	
	C-2	50,000	38.	
		271,000		
Dzerinski	A B C-1	495,000	46.1	
	C-2	130,000	41.	
		625,000		
TOTAL	A B C-1	3,592,000		
	C-2	1,331,000		
		4,923,000	Tons Sulphur Ore	
Total tons Copper Pyrite		11,376,000		
" " Sulphur "		4,923,000		
		16,299,000	GRAND TOTAL	

tnote: Reserves which have been reasonably blocked out by actual mine development are placed by the Soviet Geological Institute in Category "A". "B" represents reserves proven by drilling: "C-1" and "C-2" are "probable" and "possible" ore, respectively, the "C-2" of the Soviet geologist being of considerably easier virtue than "possible" ore in U.S.A.

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This district is fairly well prospected in the northern section; the southern part has not been prospected to definite estimates.

REMARKS

As this is an old established district, adequate housing facilities exist and delays in mill and smelter construction are not expected. The labor factor in future operations is well provided for. Power is obtained from Chelibgris, a central power station located at Cheliabinski, some 100 kms. distant. The mines are well equipped with English and American made mining equipment. Timber is plentiful.

Some trouble in operating the mill and reverberatories is being encountered but this is largely due to inexperience rather than due to faulty design and will be overcome.

The Technical Manager of this district, Mr. B. Zamen, is not popular with his assistants and the friction between them slows down operations.

The driers and sulphuric acid plant at the roasters will be completed in the first quarter of 1936.

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KRASNO URALSKI DISTRICT

URALS

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KRASNO URALSK

11a

LOCATION

In the northern part of the Ural mountains, about 14 hours night train ride from Sverdlovsk. A branch line, 12 kms. in length, links the copper deposits with Verknia, a station on the Perm-Moscow railroad.

DEPOSITS

In this district the copper pyrite and "sulphur" pyrite occur as lenses in a highly altered argillaceous schist, which at the contact is nearly white.

The most important deposits are the Krasno-Gvardeiski and Novo-Levinski both of which are in active operation.

Novo-Levinski deposit consists of three lenticular bodies of massive pyrite of total length 300 meters. The southern lens is the widest, 52 meters: the average width of the deposit - 20 meters. It has been prospected thoroughly by drill holes to a depth of 230 meters but drill holes at a depth of 400 meters did not find the ore. The Soviet geologists believe that this is due to the pitch of the orebody, the drill holes passing off to one side. On the other hand, the southern lens which has a width of 52 meters on the 110 meter level shows a reduction in width to 13 meters on 220 meters according to drill holes.

Krasno-Gvardeiski deposit is located 4 kms. from Novo-Levinski in a small quartz sericite schist area. It also consists of three lenses, of which the central lens is the most important. It has a total length of 200 meters and strikes N. 24 deg. W. The dip is to the east at an angle of 70 degs. The width of the

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central lens on the 110 meter level is 65 meters but in depth shows a rapid decrease. Drill holes at a depth of 230 meters show an average width of the orebody of 11 meters but also offer definite evidence that the south lens is pinching out.

In addition to the above orebodies some other deposits of lesser importance occur. The Spasso-Sernia-Chalcedonia orebody is 1,600 ft. long and has been worked to a depth of 845 ft. Up to 1931, this deposit was considered worked out as it was actively exploited in pre-revolutionary times for its "sulphur" pyrite ore. Drilling at a depth of 1,055 ft. cut a small lens of copper bearing pyrite averaging 5.18 per cent copper.

One large and several small "sulphur" pyrite deposits are known to exist in this district in addition to the above copper deposits, - the Andreevski located to the south of Krasno Uralski; several small lenses in the Isvinski district; one small lens in the Vinnovski; and an area near the Kaban mountain which is 35 kms. south of Krasno Uralski.

MINING OPERATIONS

The massive pyritic ore in the Krasno Gvardeiski and Novo-Levinski deposits is blocky and heavy due to the numerous slip planes running at all angles. The hanging wall is soft and unless supported causes continual difficulties. Formerly these deposits were worked by a square set and fill method but during 1931 these two mines were developed for the introduction of a mining method similar to that used at the La Touche Alaska (Beatson Mine.)

The development period for this new raise-stoping system

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(La Touche) occupied a span of four years and millions of rubles were spent. After the mines were developed and the system put in operation, it was found that the drilling of long down holes in the pyrite ore could not be accomplished satisfactorily. During 1935, following innumerable discussions and investigations by Soviet engineers, it has been unanimously agreed that the La Touche system is impossible to use. This now necessitates a slow and expensive change to another system of mining as yet undetermined. A sub-level caving system was in greatest favor at the time of our last visit but the use of this system under the present conditions, would probably lead to disastrous results. In the Krasno Gvardeiski mine a fire has already broken out in the upper levels, - due probably to the caving of the square set stopes. Should sub-level caving be introduced under this fire area, for the several hundred thousands tons of ore that are left, the fire will undoubtedly spread quickly as the ground will be loosened due to caving.

The operating levels are as follows - 110th meter in the Novo-Levinski and the 124th meter level in the Krasno Gvardeiski. The former mine is operated through an enormous circular concrete shaft - the Capitalnia, - and two auxiliary steel shafts. The latter mine is operated through a circular concrete shaft and two steel auxiliary shafts - the Comintern and Krasno Gvardeiski.

RESERVES

The following are the reserves of copper bearing pyrite and "sulphur" pyrite in this district:

(see next page)

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Name of Deposit	Tons	Per cent Sulphur
Copper Ore		
Krasno Gvardeiski		
Cat. A+B+C-1	5,667,000	40.0
C-2	1,300,000	35.0
	6,967,000	
Novo-Levinski		
Cat. A+B+C-1	6,321,000	40.0
C-2	2,931,000	35.
	9,252,000	
Spasso-Sernia-Chalchedonia		
Cat. A+B+C-1	249,000	36.
C-2	319,000	30.
	568,000	
"Sulphur" Pyrite Ore		
Andreevski		
Cat. A+B+C-1	3,574,000	48. Selenium
C-2	1,000,000	content 0.00018
	4,574,000	
Spasso-Sernia-Chalchedonia		
C-2	350,000	42.
	350,000	

POSSIBLE PRODUCTION

With a square set and fill system (probable ultimate method) taking into consideration the heavy nature of the ore, the production from this district should not exceed the following figures:

	Copper Ore
Novo-Levinski	600
Krasno Gvardeiski	600
Spasso-Sernia-Chalchedonia	300
Total	1,500 tons daily, or 450,000 tons yearly

Sulphur Pyrite Ore

Spasso-Sernia-Chalchedonia	350 tons daily or 105,000 tons yearly

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No attempt has been made to estimate production of the other "sulphur" deposits in this district with the exception of the above Spasso-Sernia-Chalchedonian, in which the sulphur pyrite will be mined simultaneously with the copper bearing pyrite lens in the nearby vicinity.

The mill already built calls for 2,700 tons of copper ore daily but this capacity is too large for the mines and was figured on the "La Touche" system basis.

On the square set and fill basis, approximately 41,000 tons of concentrates will be sent to the reverberatories every year and 409,000 tons of tailings will be re-floated. This should give approximately 256,000 tons of pyrite with 48% sulphur content. In addition, there will be 105,000 tons of sulphur ore.

The sulphuric acid production from the roaster gases should give about 4,500 tons.

The total pyrite tailings and ore for either sulphuric acid or elementary sulphur will be 361,000 tons.

METALLURGICAL OPERATIONS

A modern concrete flotation mill with a capacity of 2,700 tons daily (using Fahrenwald machines) and a modern reverberatory plant, of 20,000 tons of copper yearly, are in operation. Although these plants have been in operation for only two years, they are badly in need of repairs and the plants in general appear rather as wrecks than as newly constructed. Some changes are contemplated in the mill, and the fifth and sixth sections are to be changed to recover the small amount of zinc in the ore. In addition, machines will be added to re-float the tailings so

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as to obtain a higher percentage of sulphur.

The smelter plant is also in a dilapidated condition despite its recent erection. No provision was made for utilizing the roaster gases for sulphuric acid recovery but plans have now been made to do so.

SULPHUR EXPERIMENTAL PLANT

A small experimental plant for the purpose of extracting the free atom of sulphur from the flotation mill tailings has been in operation here for several years. While acclaimed in press as mainly Soviet brilliance, the process under trial seems to be that reflected in English patent 13,011 (1913), E.A.A. Gronwall and H.J. Nathorst, Stockholm, which states:

> "Ores are reduced in a shaft furnace by means of a carbonaceous reducing agent, the combustion gases escaping at the upper portion of the furnace and being blown back into the charge after being admixed with a quantity of fresh air."

Briquetting - Flotation tailings, which have not been re-concentrated, and containing from 38 to 40% sulphur and from 12 to 15 per cent moisture are briquetted with the addition of from 8 to 12 per cent slacked lime as binder. The machine to which this material is fed makes a briquette about 30 cubic centimeters in volume using a pressure of 1000 kilograms per square centimeter. No air drying of the briquette is done although experiments showed that the strength is somewhat increased. From 8.5 to 9.5 kilowatt hours are used to briquette one ton of material.

Distilling

Furnace Construction (See Sketch) - The experimental furnace is a cylindrical steel cylinder 5.7 meters in height and 1.8 meters in diameter, lined by two rows of fire brick. At a point

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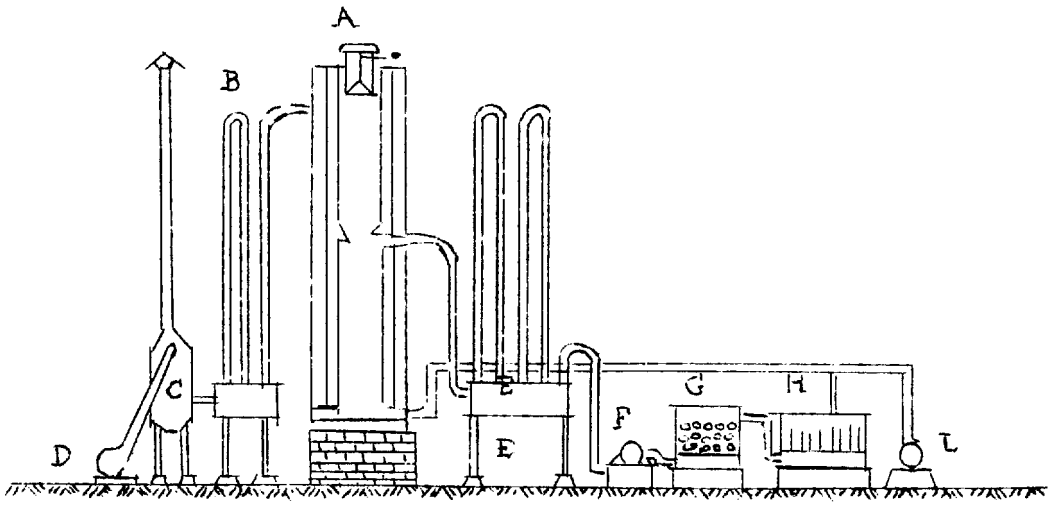
SKETCH OF LAYOUT OF KRASNO URALSKI EXPERIMENTAL SULPHUR PLANT



A - Furnace
B - Condenser
C - Chamber
D - Ejector Fan
E - Condenser
F - Booster Fan
G - Catalyst
H - Chamber
L - Primary Air Fan

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just above the middle part of the furnace, the brickwork is so formed so as to make a constriction to prevent the descending briquettes from plugging the gas outlet. At the bottom of the furnace side doors have been placed for the purpose of taking out the roasted briquettes. The tuyeres are located near the bottom and two outlets for the furnace gases are provided - one near the middle part of the furnace and the other at the top.

Furnace Operations are divided into three zones:

I. Upper part of furnace in which the drying and some roasting is done.

II. The Middle part of the furnace in which distillation of briquettes occurs.

III. Lower part in which some distillation, and oxidation of the iron occur.

The briquettes are charged into the furnace "A" at the top. The temperature is gradually raised after the 600° (C) point is reached, as it has been found that the briquettes have a tendency to crack and disintegrate under rapid temperature increases. The gases withdrawn from the upper part of the furnace are taken directly to a condenser "B" and thence through a small chamber "C" for collecting the flowers of sulphur. A fan "D" takes atmospheric air and ejects into the stack to produce a draft sufficient to expel the gases to the atmosphere. The efficiency of sulphur collection is not high, if judged from the large amount of sulphur covering the ground in the vicinity of the plant.

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At a point about midway in the furnace, a part of the ascending gases are withdrawn. These pass through a condenser "E", thence through a booster fan "F" to a catalyst "G" and chamber "H", and back to the furnace. The chamber "H" is nothing more than a steel chamber with partitions to change the flow of gas in order that sulphur of flowers may fall out of the gas stream. The catalyst is also a small chamber filled with bauxite about 25 millimeters in diameter. Some molten sulphur-dust particles that have been fused and carried over in solid form-is caught in this filter.

Atmospheric air is added for furnace operations by fan "L". This air enters the returning gas in an amount not to exceed 8.5 to 9% oxygen content. This is sufficient oxygen to prevent the furnace temperatures from exceeding 1100 degs. centigrade and to prevent smelting of the briquettes.

The primary air and returning gases enter the furnace through tuyeres at the bottom. Coke fuel is used. Some trouble is experienced at this point in agglomeration of the briquettes. In addition, when discharging the furnace through the sides, the pressure falls to a point to cause some trouble. Several attempts have been made to introduce tuyeres which will give a better distribution of air, a point which has caused much difficulty in that from 20 to 30 per cent of the briquettes in some runs have not been roasted completely. It has been found that from 40 to 50 hours has been necessary to roast these briquettes.

The following data is the result of a twenty day test run, (Oct. 3 to 23, 1934) as given by Prof. Shabalin:

The figures are daily averages:

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TWENTY DAY TEST

Day	Press. Top Furnace M.M.	Press. Bottom Furnace M.M.	Temp. outlet Gases	Percent SO_2 Outlet gas	Percent Oxygen Outlet gas	Temp. Return Gas (°C)	% SO_2 Returned gas	% Oxygen Returned gas Outlet
1	-0.3	23	107	-	-	463	11.0	0.5
2	-0.2	26	83	10.0	0.3	465	11.1	0.3
3	-0.4	31	61	8.6	0.4	477	11.2	0.3
4	-0.3	31	95	8.7	0.6	483	10.9	0.4
5	0.0	19	71	6.4	0.8	488	9.6	0.4
6	-0.4	23	120	8.0	0.7	565	11.1	0.3
7	-0.5	27	118	8.2	0.5	555	10.7	0.2
8	+0.5	22	50	5.7	0.6	471	9.6	0.2
9	-0.4	34	105	5.9	0.3	524	10.0	0.2
10	+0.5	39	130	7.5	0.7	515	10.8	0.1
11	+0.5	26	68	5.9	0.6	481	10.4	0.2
12	-0.2	28	107	5.9	0.4	485	10.7	0.2
13	0.0	25	135	6.4	0.2	548	10.9	0.3
14	-	35	111	7.7	0.2	490	10.8	0.2
15	-1.0	27	159	5.7	0.3	550	11.5	0.2
16	-	31	169	5.1	0.5	538	10.7	0.3
17	-	30	168	6.0	0.2	559	10.6	0.3
18	-	20	192	6.7	0.1	574	10.7	0.4
19	-	13	160	6.8	0.2	545	11.4	0.2
20	-	23	173	7.4	0.3	535	11.5	0.2
Average	-0.2	26.5	170	6.9	0.4	503	10.7	0.3

TWENTY DAY TEST CONTINUED

ANALYSIS FINAL BRIQUETTE AFTER DISCHARGING

Day	% mixed gas inlet SO_2 %	Oxygen O_2 %	Iron %	Sulphur as sulphide %	Sulphur as sulphate %	Total sulphur	Tons Briquettes
1	6.5	8.4	39.60	10.60	4.22	14.82	3.217
2	5.9	8.6	37.28	13.42	4.50	17.92	2.033
3	6.6	8.6	39.93	10.49	4.05	14.54	2.568
4	5.7	8.6	38.56	10.20	4.31	14.51	2.354
5	5.6	8.2	38.23	12.22	4.36	17.08	2.354
6	6.3	8.6	39.79	10.09	3.79	13.88	2.140
7	5.8	8.9	36.26	11.30	4.20	15.50	3.210
8	5.5	8.8	42.46	11.40	3.58	14.98	3.317
9	5.7	8.4	39.26	10.82	4.43	15.25	2.354
10	5.9	9.1	40.49	10.93	4.27	15.20	3.424
11	6.0	8.6	38.49	12.77	4.74	17.51	2.889
12	5.8	8.6	44.93	11.38	3.97	15.35	2.889
13	5.8	8.5	40.05	14.36	3.97	18.33	2.247
14	6.0	8.5	37.63	11.86	4.43	16.29	2.354
15	6.5	8.5	38.56	10.20	4.31	14.51	2.568
16	5.9	8.4	39.04	10.96	4.08	15.04	2.247
17	6.1	8.6	40.34	11.75	4.74	16.49	2.100
18	6.3	8.4	39.04	10.96	4.08	15.04	2.265
19	6.0	8.6	42.46	11.40	3.58	14.98	3.045
20	6.6	8.4	40.22	10.44	4.06	14.50	1.605
Aver.	6.0	8.5	39.63	11.38	4.21	15.59	2.570

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The average composition of the briquettes during this test was as follows:

Iron	32.03%
Sulphur in sulphate	0.56%
Sulphur in sulphide	34.44%
Total Sulphur	35.00%

During the test 51.53 tons of briquettes were charged to the plant and 7.61 tons of impure sulphur as either molten sulphur or as flowers were received. The purity of the sulphur was as follows:

	Flowers of sulphur	Molten sulphur
Sulphur	96.73%	99.34%
Ashes	2.65%	0.25%
Moisture	1.62%	0.09%

This gives an average of sulphur obtained as approximately 98.04%, therefore 7.60 x 98.04 gives 7.46 tons of pure sulphur. The sulphur charged to the furnace was 51.53 x 35% (total percentage of sulphur) or 18.03 tons. 7.46/18.03 gives a recovery of 41.4% of the total sulphur charged. Prof. Shabalin believes and there is much evidence to support him that a still greater percentage of recovery could be made if improvements in condensers, etc. are made.

From the result of these tests he has made the following calculations as to the cost of one ton of sulphur - If the burned briquette is to be utilized farther the cost of a ton should not exceed 63 rubles, the sale value of the briquettes to the iron industry being calculated at 40 rubles. If not utilized, the cost will be 103 rubles which is a figure, as he says, "reasonable under Soviet conditions."

On the basis of these experiments he has submitted plans to the government for the erection of a 10,000 ton per year sulphur plant at this place but to date (Fall, 1935) no decision has been given on it.

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REMARKS

Undoubtedly improvements can be made for obtaining more sulphur from the furnace as the present equipment is make-shift but it will be a high cost producer of sulphur under any circumstance. Costs under Soviet conditions should not be given too much significance as a ton of blister copper at this same Krasno Uralski plant costs on an average during 1934, 1680 rubles which at 1.13 rubles to the dollar exchange is far out of range of the world market price of copper. This gives a cost of 75 kopecks (66 cents) per pound of copper (without refining.) Figured on the same ruble exchange basis (1.13) a ton of sulphur at a cost of 103 rubles may be "reasonable under Soviet conditions" but in good American dollars it looks like $91.15.*

It seems unlikely that a sale of the burned briquette can be made at the present time but nothing is impossible in Soviet internal economics.

The mines, mills and smelters are well equipped with foreign machinery but all of it is in need of repair. At the present time operations are suffering from the lack of mine plans.

Mr. B. Ustenov is the Technical Director of this district.

*Footnote: Accurate interpretation of the cost of producing sulphur in the Soviet Union is virtually impossible in terms of American or Italian reckoning. Even when presented with the exact statement of costs in rubles, (the only medium of Soviet accounting) the foreign accountant, no matter how expert, is puzzled to determine the real production cost in world values for the reason that there is no completely adequate measure of the value of the Soviet paper currency. Now nominally 20 cents (to which it was changed, from 39 cents, by a November Government decree - these official values being arbitrary rates, for foreign exchange purposes at the border) - 1 to 3 cents on the Black Bourses

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of Poland, Germany or Manchukuo - with the native Soviet population inside the country willing to exchange rubles for an American dollar at rates that have slid down from 55 (1930) to about 20 (1935) - and with the menus of the large tourist hotels in Moscow and Leningrad carrying optional prices of $1.00 or 10 to 12 rubles for one and the same portion of food, the intrinsic value of the Soviet ruble has been anybody's guess.

Appraising it, however, from the average experience of foreigners during a year or two of actual living in the country (between 1930 and 1935) it has, in the long run, procured for the spender about 10 cents' worth of assorted merchandise. Its recent fixation at 5 to the dollar - November 1935 - is at double this average trade value, but it is a fact that the 1935-1936 purchasing power of the ruble is steadily going up. "108 rubles" for a long ton of sulphur by the Shaballin process would thus, at say 15 cents actual average value, represent a production cost, in world values, of about $15.00 instead of [redacted].00.

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SAN DONATO DISTRICT

URALS

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SAN DONATO DISTRICT

LOCATION

This district in the north Urals lies south of the Krasno Uralski district. It is located about 1.5 kms. from San Donato, a station on the Perm railroad and about 10 kms. north of Nijni Tagil, an important iron and manufacturing center.

DEPOSITS

Four deposits are known here, three of which are polymetallic and the other "sulphur" pyrite.

Third International Deposit, the most important, consists of three lenses in the upper level but only two lenses at the 120 meter level. The two lenses on the lower level have a total length of 250 meters, width 4. The deposit is prospected thoroughly to a depth of 800 meters with one hole cutting ore at 300 meters. The dip of the lenses is 65 to 75 degrees to the east and the pitch 60 degs. to the north. The principal minerals are zinc blende, chalcopyrite, pyrite, arseno-pyrite and gold. The copper and zinc contents are high, - 5.4% and 14.5% respectively. The hanging wall at the contact with the massive sulphide ore is composed of a zone of quicksand which makes support necessary.

Dinamitnia deposit, located one half kilometer to the northeast of the Third International, also consists of a series of lenses, - of total length 200 meters with an average width of 3 meters. It has been prospected to a depth of 150 meters. The copper and zinc average 10 and 7 per cent respectively. The same weak condition of the hanging wall is evident here.

Olchovka deposit, located three kilometers north of the Dinamitnia,

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137 is a continuous lens 250 meters in length and about 5 meters wide. It has been prospected by a drift along its entire length on the 20 meter level and by four drill holes at a depth of 100 meters. The ore is low in copper, 1.0%, and high in zinc, 9.8%. In some sections only disseminated and "sulphur" pyrite ore is found. The hanging wall in this mine shows no presence of quicksands.

Sernia deposit, located three kilometers west of the Third International deposit, is purely "sulphur" pyrite ore. It was mined formerly by an open pit method but as this proved too expensive, underground operations have been resorted to. It has a length of 100 meters and a width of 20 meters. It dips to the east at an angle of 60 degrees.

MINING

The Dinamita and Third International polymetallic deposits are mined by a sub-level caving system. This system has not been in operation long but the temperatures are already very high under the timber mat. One fire has broken out already according to Mr. Banketov, the Technical Director, but was extinguished. In a conversation with him (1935), he expressed the fear that additional fires will result but intends to carry on the work because the system has resulted in a higher production per man shift. As far as costs are concerned, the old system of square set and fill gave lower costs than sub-level caving (due to the large amount of development necessary in orebodies of four meters width.)

133 The Olchovka deposit is under development and awaiting the erection of a mill. The Sernia deposit is (at this writing) under development for a sub-level caving method, but it is almost

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13/ a certainty that despite this start in the wrong direction, the final system will be square setting.*

All mines will be connected on the 120 meter level with a centrally located shaft called the "Novia". This shaft has been sunk and drifting is under way to the various lenses in operation.

METALLURGICAL OPERATIONS

There are no metallurgical plants in operation or under construction here. Plans have been made for the erection of a 2000 ton flotation mill but the design of the plant has not been entirely agreed upon. Experiments showed that unless re-flotation of the tailings is done there is a complete loss of the zinc and gold in the tailings. Even with re-flotation of the tailings the gold presents a difficult problem. The Olchovka deposit of low grade copper and high grade zinc will remain idle until the erection of the mill.

At present the high grade copper-zinc-gold ores are sent to the blast furnaces at Kalata. The copper and gold are recovered but the zinc is lost.

SULPHUR PLANS

The mining and shipping of the "sulphur" pyrite ore from the Sernia mine is the only "sulphur" plan under consideration in this district. Despite the large amount of sulphur-bearing flotation

*Footnote: Personal discussion with Banketov, (Technical Director of San Donato Group) and Ageev (another Soviet engineer with whom it was discussed.) These men are starting a swing in this direction, convinced of the necessity of square setting.

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tailings already available in the Urals, the operation of this Sernia mine will continue as it is linked to the Central shaft "Slovia" and it is thought best to mine it at the same time with the other polymetallic deposits.

POSSIBLE PRODUCTION

There are only two mines here that will enter the sulphur plans - they are the Olchovka and the Sernia. The following estimate of their possible production has been based on the use of a square set system and fill in the wider Sernia and of incline cut and fill in the narrower Olchovka deposit.

Olchovka	500 tons
Sernia	750 "
	1250 tons daily

In addition, some consideration should be given to the Third International and Dinamita mines as the design of the mill may incorporate use of the tailings for sulphuric acid, but two reflotations of the tailings appear to be remote at the present time.

With a square set system in the wide parts of these lenses with incline cut and fill in the narrower, the Third International and Dinamita should produce 500 and 300 tons respectively.

Therefore, the yearly tonnage of sulphur ore from this district should not exceed 375,000 tons and the copper pyrite not over 240,000 tons.

RESERVES

Polymetallic Ore

Name of Deposit	Tons, Ore
Dinamita	
A B C-1	67,000
C-2	260,000
	327,000

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Polymetallic Ore (continued)

Name of Deposit	Tons, Ore	Sulphur%	Selenium%
Third International			
A B C-1	1,329,000		
C-2	----		
	1,329,000		
Olchovka			
A B C-1	1,016,000		
C-2	1,000,800		
	2,016,800		
"Sulphur" pyrite ore			
Sernia			
A B C-1	2,499,000	42.9	0.003
C-2	1,278,000	42.16	
	3,777,000		
Total Polymetallic Ore			
A B C-1	2,412,000		
C-2	1,260,800		
	3,672,800		

REMARKS

The district is admirably located as regards to transportation facilities. The Technical Manager, Mr. A. Banketov, is lacking in practical experience which shows throughout the whole organization.

Power is obtained from the central steam power plant at Nijni Tagil. Timber is abundant but water is scarce and must be pumped from some five kilometers away.

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BLAIVA DISTRICT

URALS

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BLAIVA DISTRICT

LOCATION

This district, under the management of Glavzoloto, (Gold Trust) is a 1952 discovery. It is situated in the steppes just southwest of the Ural Mountains. A branch line railroad, five miles in length, links the copper-gold deposit with Blaiva, a station on the Troitsk-Orsk-Orenburg railroad. Both the main line and branch line are in poor condition.

DEPOSIT

The Blaiva deposit is composed of two lenses, one of major importance, the other very small. The main lens has a length of 500 meters and a width varying from 35 to 40 meters. The dip of this lens is to the southwest at an angle varying from 40 to 55 degrees: the steeper angle being found in the lower drill holes.

A wide spread iron hat and a leached zone similar to that at Degtiarka covers the massive sulphide zone. In some places alluvials are found to a depth of 30 meters. The leached zone is high in sulphur content and low in copper and is to be mined for its sulphur content only. The iron hat contains 1.85 grams of gold and will be mined for its gold and oxidized copper content despite the extremely low grades. Hole Number 21 which cut the orebody at depth shows that the massive sulphide zone is well fractured and that the higher grade copper ore is found along the footwall side. Toward the hanging wall the ore grades gradually into one important only for its sulphur content.

MINING

This deposit, located on a small hill, is now being opened

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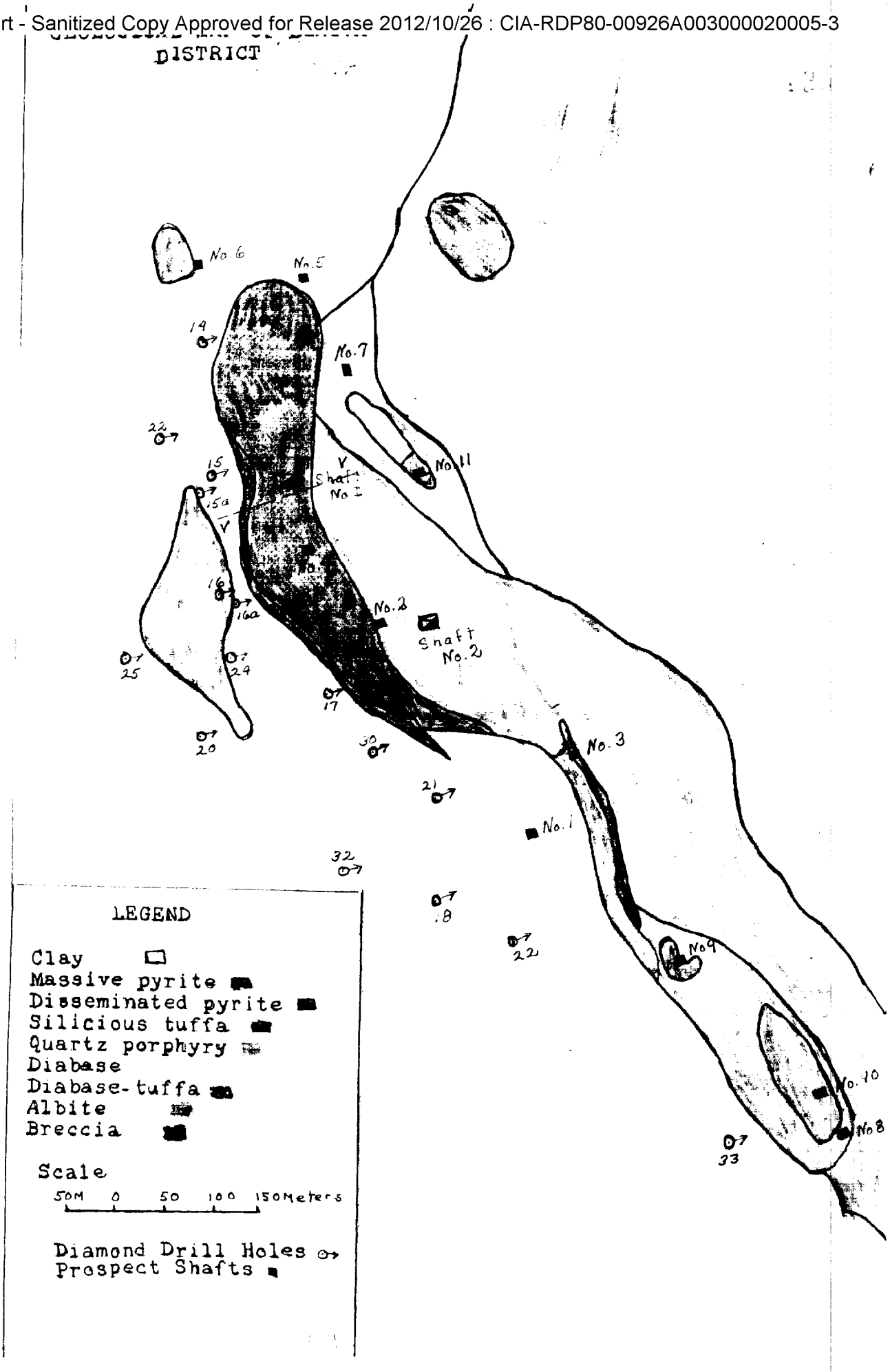

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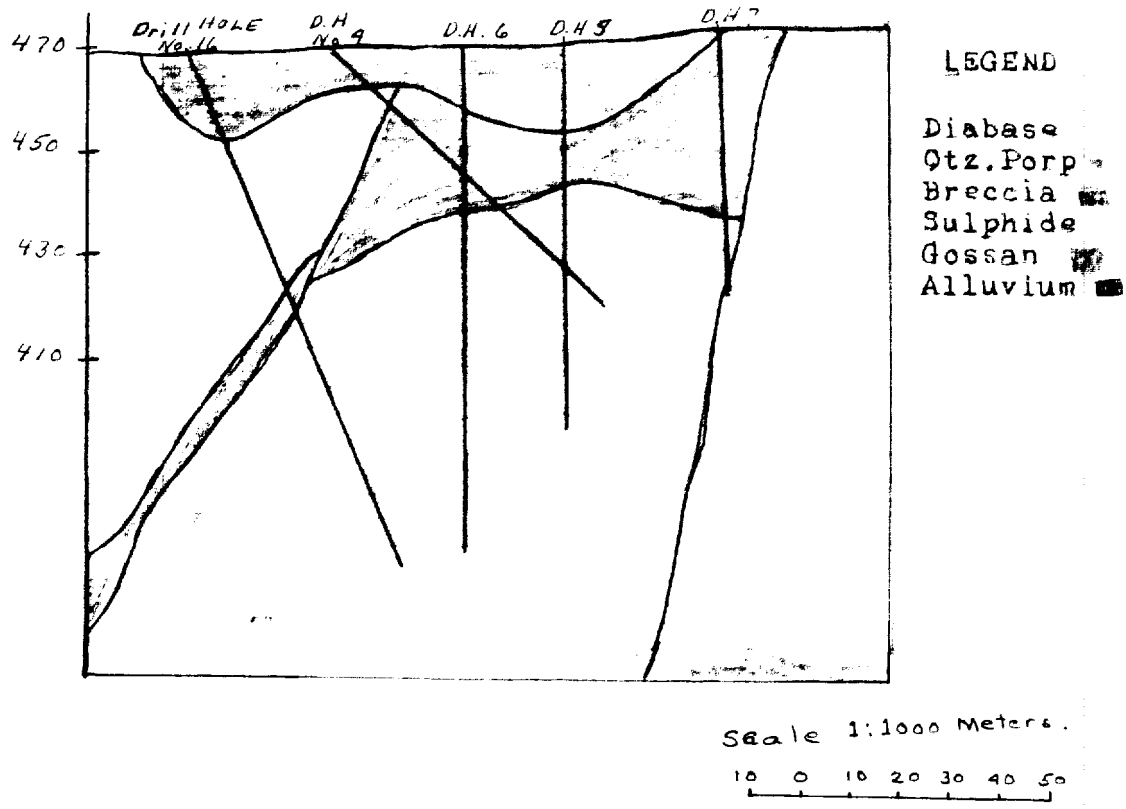
BLAIVA DEPOSIT



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by an adit which will undercut approximately 100 meters of ore. Two small shafts have been sunk to a depth of 20 meters for exploration purposes only.

Although the upper part is easily opened by means of the adit, the mining of this orebody will present many serious difficulties which will alter the original plans, once in operation. In the planned metallurgical operations, the gossan, the leached, and massive sulphide zones all play an important part as can be seen under Metallurgical Treatment of this ore. This necessitates mining all three zones simultaneously or in other words undercutting the orebody at three different points. This will cause additional pressure other than that due to the weak condition of the hanging wall and ore and result in slowing up the mining work in each zone.

A square set system and fill will be introduced but as timber must be procured some distance away, delays will be experienced in the timber supply, especially during the summer months.

METALLURGICAL OPERATIONS

The metallurgical plant, under construction, was approximately 35 per cent completed. (April 1935).

The massive sulphide ore, crushed and screened, over 25 millimeters, will be sent to shaft furnaces (of closed throat construction), charged with an excess of coke. A low grade matte containing 7 per cent copper is expected which in turn will be charged to other shaft furnaces to raise the grade of the matte to 25 per cent copper. From these latter furnaces, the matte will be taken to the converters.

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The ore from the leached and gossan zones, containing some sulphides of copper and also gold will be first roasted and then leached by a dilute sulphuric acid wash. Following this sulphuric acid treatment, dilute syanide solutions are to be pumped into the same tanks containing the above ore for the purpose of extracting the gold.

SULPHUR PLANS

The sulphur gases from the roasting of the leached and gossan ores (containing considerable amounts sulphides) is to be utilized for the manufacture of sulphuric acid.

The gases from the shaft furnaces are to be utilized for the production of elementary sulphur by the Ushkevich procedure.

With an annual tonnage planned of 1,350,000 tons of ore, this Blaiva development is being given precedence in Soviet mining developments. The elementary sulphur production is expected by Moscow to amount to 250,000 tons; sulphuric acid, 600,000 tons.

POSSIBLE PRODUCTION

Under the conditions of excessive pressure, lack of timber, relatively small length of the orebody, the use of a block square set system and fill, and delays due to the simultaneous mining of three zones of ore, the planned production figure of 1,350,000 appears entirely too high. A studied appraisal of possibilities, during a year spent in the vicinity indicates that a figure of one-third that amount is about the best performance to be reasonably expected and the planned sulphur figures must be cut accordingly. In other words the elementary sulphur should in no

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cause exceed 80,000 tons and the sulphuric acid 200,000 tons annually. Even this estimate assumes completely successful tackling by of the troublesome Ushkevich method of sulphur from gases.

RESERVES

Although one of the drill holes into this orebody has gone to 400 meters (No. 85 on Geol. Map) the geologists are not agreed as to the reserves of metal at Blagodat. There is no apparent Soviet disagreement on the tonnage of ore; but the copper content is not yet settled, as between 2.14 and 1.50%.

The Soviet preliminary estimate on tonnage of ore, all categories, is 84,000,000 tons, 2.14 per cent copper, 45.31 per cent sulphur, and 1.5 grams of gold.

Other indications of copper pyrite deposits are noted at Mugadjar, 130 kilometers west of Orsk and between Burabi and Guy. No accurate information is available so no account of these are taken in the above reserves.

REMARKS

This deposit is favorably located in regard to demand for sulphuric acid. In the treatment of the Aktiubinski iron-nickel ores large quantities of acid will be necessary. There is also a demand for sulphuric acid for the manufacture of superphosphates by the Khlilovski plant which is located in the nearby vicinity.

Lumber and labor are scarce. It will be a high cost producer due to the mining system and as coke must be transported for smelter operations from Kuznetsk coal basin in Siberia some

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2,000 miles distant.

The Manager, Mr. K. Kolastinsk, seems capable and energetic but is short of labor and adequate housing conditions. As in all other new Soviet mining operations the construction of an adequate modern workers' town will follow in due course.

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BAIMAK DISTRICT

URALS

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BAIMAK DISTRICT

LOCATION

This district, under the managment of Glavzoloto (Gold Trust), lies in the central part of the Bashkiria Province, approximately 150 kilometers southwest of the steel city of Magnitogorsk and 165 kilometers north of Sara, a station on the Orenburg Troitsk railroad. In winter it is accessible by horse and sled and in summer by auto over a very poor road.

DEPOSITS

Of the seven known pyrite deposits in this district - three are practically exhausted. The seven are:

Bakrusak - located 60 kilometers southwest of Magnitogorsk and 65 kilometers north east of Baimak, the smelter site, - a deposit 70 meters long and 1 to 5 meters in width. On the 75 meter level five separate veins are found. Operating levels are on the 105 and 135 meter levels; prospecting here has gone to a depth of 135 meters. The ores, containing copper and zinc, are characterized by their relatively high gold, copper and silver content, - 18 grams, 13% and 57 grams, respectively.

Cebi is located 30 kilometers northwest of Baimak. The deposit shows alternate layers of pyrite and schist and in cross section from north to south has an elliptical form, 800 meters long, 600 wide.

Tubinski, located 40 kilometers north of Baimak, has two lenses - East and west. Both have a length of 100 meters, the East

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Lens being, 4.5 meters wide; West Lens, 3 meters. This deposit is practically worked out with the exception of its low grade ore.

Ulali deposit is located 19 kilometers south of Baimak and is connected with the smelter by a narrow gauge railroad. It is a steeply dipping lens of varying widths - 1 to 12 meters. The mine is practically exhausted though a small amount of low grade ore is still available on the 120 meter level.

Burabai - located 85 kilometers south of Baimak, on the left bank of the Tanalyk river, has a length of 250 meters with an average width of 40. It is thoroughly prospected to a depth of 100 meters. The gossan is high in gold value and this ore is mined and treated in a 50 ton amalgamation and cyanide plant located nearby. Under this iron hat or gossan is a zone of leached pyrite ore high in sulphur which must be mined and shipped for its sulphur content. Just below this leached zone are the massive sulphides.

Uluk deposit is located 35 kilometers southwest of Baimak, - out of the volcanic zone of rocks. The deposit consists of alternate layers of flat dipping pyrite up to 6 meters in thickness. The hanging wall as well as the alternate bands of waste consist of a graphitic-quartz-albite schist. It has a length of 250 meters and has been prospected to a depth of 100 meters. A shaft has been sunk to the 92 meter level.

Gumerovski is a new deposit located 19 kilometers south of the Uluk deposit. One drill hole cut 17 meters of massive pyrite. The deposit is still under exploration.

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MINING

The three deposits now in operation - theBakrusak, Ulali, and Tubinski, - are mined by a square set and fill method.

The Burabai mine now under development will be mined by a block square set system and fill which seems to be the safest method for this deposit.

The Cebi deposit, also being developed, will adopt an open pit method. This method will undoubtedly prove expensive as the hanging wall and ore, although broken, will need drilling and blasting. In addition, the ratio of waste to ore is high. The severe winter climatic conditions will seriously hamper shovel operations and cause irregular operation.
The Uluk deposit will be mined by an open stope with timber support but under any system the mining of this deposit will be very difficult, costly and slow. The hanging wall is soft, and the layers of pyrite narrow.

METALLURGICAL OPERATIONS

At the present time there are two - 200 ton blast furnaces at Baimak, centrally located in respect to the mines. A 1,500 ton flotation mill is under construction at Cebi and a 1,000 ton mill at Burabai. No provision has been made for using the smelter gases.

SULPHUR PLANS

No provision has been made in the flotation mills for re-flotation of the tailings at Cebi as the grade of ore will be low here due to the open pit method. Should this system prove

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unsatisfactory, and open pit methods be abandoned, additional flotation machines will be added, to raise the sulphur content of the tailings. At Burabai provision for re-flotation has been made but production here depends largely on transportation. A railroad line has been planned to link Magnitogorsk, Bakrusak, Baimak, Burabai and Sara but no work has been started as yet. When this is constructed, arrangements can be made for the utilization of the pyrite tailings but until this railroad becomes a fact, no plan for sulphuric acid or sulphur production will amount to anything.

POSSIBLE PRODUCTION

In the following estimates of possible production of the Baimak district, no consideration has been taken of the production possible from the present operating mines - the Bakrusak, Ulali and Tubinski, as these will undoubtedly be exhausted before the railroad is completed.

Of the remaining deposits - the Cebi, Uluk, Burabai and Gumerovski, the Burabai and Cebi are the most important. In the latter, the production of pyrite tailings is dependent upon the mining system to be used. If open pit, then no tailings will be available for re-flotation. In the following estimate it is presumed that Cebi will operate as an underground mine, its tailings being utilized.

The maximum daily tonnages possible from this district are:

Uluk Mine	150	tons
Cebi "	750	"
Gumerovski	250	"
Burabai	750	"
Total	1,900	" or 570,000 tons of ore yearly

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Approximately 50,000 tons of concentrates will be roasted and sent to the reverberatory plant. If the gases from the roasters are to be utilized for sulphuric acid manufacture, about 5,000 tons of sulphuric acid will be gained from this source.

The remaining 520,000 tons of tailings may or may not be re-floated. Should they be re-floated, approximately 325,000 tons of pyrite tailings of 48 per cent sulphur are available for either elementary sulphur or sulphuric acid.

RESERVES

The following are the reserves for this district:

Name of Deposit		Tons, Ore	Sulphur %
Cebi			
A B C-1		8,500,000	30.1
C-2		450,000	30
		8,950,000	
Burabai			
A B C-1		2,839,000	44.2
C-2		3,400,000	37.
		6,230,000	
Uluk			
A B C-1		282,000	45.0
C-2		840,000	38.
		1,122,000	
Ulali			
A B C-1		114,500	45.0
C-2		203,000	40.
		317,500	
Baksurak			
A B C-1		175,500	38.
C-2		181,000	38
		356,500	
Tubinski			
A B C-1		139,000	44.
C-2		105,000	40.
		244,000	
Gumerovski	-	Considerable. No accurate estimate available.	
Total Reserves of District. . . .	A B C-1	12,041,000	
	C-2	5,179,000	
		17,220,000	tons

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Electrical prospecting in the district between Burabai and Blaiva has indicated other pyritic deposits but no definite data is available on these.

REMARKS

Although the "sulphur" plans for this district are still undecided because of the lack of adequate rail transportation certain consideration must be given to them. The railroad which will link Magnitogorsk with Sara via Baksurak, Baimak, Cebi and Burabai has been approved by the government and it will have other importance than as a purely "mineral" railroad. It will tap an agricultural district and at the same time provide a shorter route for the steel and iron products of Magnitogorsk to Middle Asia. The important manganese deposits in the latter district are needed at the steel plants. The line will have loaded traffic in both directions. Until its completion no attempt is to be made to use the pyrite tailings.

Timber is scarce and must be procured some 90 kilometers away. The Burabai mill will have an adequate supply of water but the same cannot be said of the Cebi mill which is dependent on small streams which freeze solid in severe weather.

The supply of labor is scarce during the summer months, and at all times inefficient. As this district is under the management of the Gold Trust more attention is paid to the gold deposits in this region than to the low grade copper. Mr. Secon is the Technical Manager.

The Burabai and Cebi mill construction is progressing very slowly due to lack of transportation of materials which are piled up inlarge amounts at Sara. At present rate of progress these mills will not be in operation until 1937 or early 1938.

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PISHMA DISTRICT

CRALS

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PISHMA DISTRICT

LOCATION

Is situated 12 kms. north of Sverdlovsk and connected with it by a broad gauge branch line railroad. This is the site of the new 100,000 ton copper refinery which will handle all the Ural copper production.

DEPOSITS

The copper-zinc pyrite orebodies in this district occur as narrow parallel lenses in an area 1½ square kilometers. They are found in chlorite schist and Uralite porphyry. In all about 40 separate lenses are known here, the most important the Alexandrovski, Pokrovski, Srednie, Mareienski and Ivanovski. They vary in length from 160 to 400 meters and in width from 0.4 to 1.8 meters. They dip at various angles from 30 to nearly vertical, to the west.

MINING OPERATIONS

Square set and cut and fill are the methods used, the fill obtained from the waste rock shot down in mining the narrow lenses. The old Alexandrovski shaft has been retimbered for use as a central ore hoisting shaft. A large amount of water is encountered in all mines here which makes development difficult and costly.

POSSIBLE PRODUCTION

A daily tonnage of 500 tons or a yearly tonnage of 150,000 tons which is sufficient to meet the requirements of the present

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flotation mill is all that is possible from this district and no plans have been made to increase this amount.

METALLURGICAL OPERATIONS

A modern flotation mill of 500 tons daily capacity is in operation here. At the present time, as mining operations do not produce sufficient ore to meet the mill requirements, additional ore is brought from Degtiarka.

SULPHUR PLANS

No plans for sulphur have been made here with the exception of a planned addition of other flotation units for re-floating the tailings and of drying them for shipment to other points. The concentrates from this mill are shipped to Karabash District at present but as soon as the Degtiarka plant will be in operation, the concentrates will be handled at that point.

RESERVES

The ore is polymetallic with very little area that can be designated as "sulphur" pyrite. The following reserves are given for this district:

Category	Tons Ore
A B C-1	1,868,000
C-2	682,000
Total	2,550,000

There is little likelihood of finding additional orebodies here as the district has been well prospected to a depth of 250 meters.

REMARKS

This district has little importance except as a small producer of flotation mill tailings for use in the sulphuric acid industry.

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POLEVSKI DISTRICT

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LOCATION

This district is located south of Sverdlovsk - about midway between that city and Kyshtim, a station on the Moscow-Sverdlovsk-Chelyabinsk-Siberia railroad.

DEPOSITS

The deposits in this district are primarily "sulphur" pyrite although some "copper" pyrite deposits are present.

ZULESKI, the principal deposit, is worked solely for its "sulphur" pyrite - little or no minable copper pyrites are found. There are two lenses, each about 90 meters long. The width of the west lens is 40 meters; east, 10 meters. Both lenses strike N. 75 E. and dip east at an angle of 70 degrees.

Drill holes in the hanging wall disclosed a series of small copper pyrite lenses, the largest having a width of 8 meters - the average width, all these lenses, being 0.7 meters.

North of the Zuleski deposit, electric l survey has given good indication of additional pyrite deposits.

ZAMOVKI deposit is located seven l kilometers east of the Polevski sulphur and sulphuric acid plant. The deposit consists of one lens approximately 50 meters in length with an average width of 10 meters. This deposit has been prospected to a depth of 40 meters and the ore is solely "sulphur" pyrite. At the present time this deposit is not worked.

GUMESHEVSKI deposit, situated 2½ kilometers west of the Polevski Plant, is at the contact of the limestone and granite. This deposit has not been worked since 1370 but during the period of

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its exploitation, had a record of 900,000 tons of 4% copper ore. It has been worked out to the 100 meters level. As the ore mined in the past was an oxidized zone, local geologists believe that a massive sulphide deposit will be found at some depth below. Drilling of this deposit will be started in the near future.

MINING OPERATIONS

The Zuleski mine is the only one operating. The system used is square set and fill. The mine is under the management of the Chemical Trust and is well equipped.

METALLURGICAL OPERATIONS

A sulphuric acid and elementary sulphur plant is located at Polevski. Three small " shkevich" furnaces are in use here. One of these furnaces has a capacity of 30 tons pyrite daily; the second, 20; third, 15 tons.

The scheme of obtaining elementary sulphur is essentially the same as that at Kalata. The tailings for these furnaces are brought in from Degtiarka and from Kishma. The lump ore from the Zuleski mine is used for sulphuric acid manufacture.

Plans have been made for increasing this plant considerably but these have been shelved at the present time as there is an idea of stopping mining operations in this district and moving the plant to nearby copper pyrite districts.

During 1934, the Polevski plant produced approximately 2,600 tons of elementary sulphur. For 1935, the figures will be a little higher but the gain will not exceed 10 per cent.

RESERVES

The following represent the Polevski reserves: No consideration was taken of the Gumeshevski and Panovski deposits.

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"Sulphur" pyrite

Zuleski Deposit A B C-1	1,280,000	43.5 % Sulphur	No Selenium
C-2	-	-	-
	1,280,000		

Copper Pyrite Ore

C-2	300,000	3.0 % Copper	38.0% Sulphur

REMARKS

The closing of mining operations in this district seems likely to come about as there is a large excess of tailings and of lump sulphur ore available in the nearby mining districts. This plant was constructed before the Soviets became "sulphur conscious" but it will operate for some years to come, until the future large plants go into operation.

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PHOSPHORIC ACID and [illegible] SECONDARY

SULPHUR PLANT

URALS

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PERM SULPHURIC ACID AND ELEMENTARY SULPHUR PLANT

LOCATION

The plant is located at the City of Perm, which is on the European or west side of the Ural Mountains. Perm is a fairly large industrial city on the Moscow-Sverdlovsk-Siberia railroad.

METALLURGICAL OPERATIONS

The contact system sulphuric acid plant obtains its material from the Krasno Uralski and Third International districts. The elementary sulphur plant consists of six Ushkevich furnaces - three of rectangular and three of round type, of following capacities:

Two	-	15	tons pyrite daily	
One	-	20	"	"
One	-	25	"	"
Two	-	50	"	"
TOTAL		135	"	"

This elementary sulphur plant has practically the same lay-out as at Kalata with the exception of the innovations recently introduced at the latter place.

Plans have been discussed for increasing the capacity of this plant but nothing has been done about it for the same reasons given for the future of the Polevski plant to enlarge its capacity - that is - the new plan to locate sulphuric acid and elementary sulphur plants at the mines. The existing furnaces will, however, be equipped with pneumatic conveyors in the near future.

During 1934, this plant had a reported production of 8,100 tons of elementary sulphur.

In general, this plant is in a dilapidated condition. Practi-

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cally all the equipment is in a bad state of repair. The uncertainty of local sulphuric acid and sulphur plans have been largely responsible but the natural inaptitude of the Russian worker for the care of mechanical equipment has also been a factor.

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MISCELLANEOUS

URAL COPPER

DEPOSITS

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OTHER URAL DEPOSITS

In addition to the copper pyrite deposits in the Ural region some Contact Metamorphic deposits are represented by those of the Turinsk district in the North Urals. The ores, of siliceous character carrying chalcopyrite, pyrrhotite, bornite, native copper, iron pyrite and magnetite occur associated with augite garnet rocks at the contact between porphyry and limestone. The deposits occur in a belt three miles long and, in general, strike slightly west of north. These mines are being worked at the present time but tonnage will continue small, due to the slow development in the tough augite rocks and also due to the condition in which the former owners left the properties.

Copper magnetite deposits are the Kusrb ch, Third North Mine and Gora Vysokaia (Middle Urals.) Although it is hoped that the problem of extracting the copper from this ore has been solved and that the residue may be used in connection with the Ferrous Metal Trust, the latter has had difficulties with this type of deposit, and it is doubtful whether these ores will be of great economic importance for some time to come. The copper and sulphur content is low.

Copper deposits also occur in the Ural sandstones. Hundreds of small irregular deposits occurring in Permian sandstone have been traced along the western slope of the Urals for a thousand kilometers. They vary in depth from 234 ft. to those found on the surface; and in general lie nearly horizontal. At the present time they have little economic importance.

Copper disseminations in gabbro are found at the Volkovski

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mine, in the Krivoy Urelski district. It is possible that this deposit will be mined by introduction of large scale methods.

Bodies of diorite porphyry disseminated copper were found in the Vesnovskoye deposit, in the Tobelinsk district of Bashkiria. This deposit at the present time has little commercial importance.

The above type of deposits, with the exception of the Turinski have little economic importance at the present time. If and when beneficiated, the concentrates will carry but 10 to 25% sulphur. Their copper grade is so low that Soviet production must continue from the pyrite fields until latter have been exhausted. This means that copper pyrite flotation buildings will continue to pile up, for lack of elementary sulphur outlet.

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COPPER AND PYRITE DEPOSITS

OTHER THAN URALS

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COPPER AND PYRITE DEPOSITS OUTSIDE THE URALS

In addition to the important cupreous and non-cupreous pyritic deposits of the Urals, there are from the sulphur point of view, other regions containing copper deposits which are worthy of mention since they will in their smelter design incorporate means to recover sulphuric acid:

TRANS CAUCASUS

In this region, the bulk of the copper reserves are found in a porphyry deposit located at Agarak. At Allaverdi on the Tiflis Erivan railroad stock-shaped deposits of copper are found. At this place a smelter and sulphuric acid plant is in operation. At Zangezour, there are two separate groups of mines, the Lenin and Shaumian. A 2,000 ton flotation mill and enlarged smelter will be in operation in a short time. A sulphuric acid plant is also under construction here. Other Transcaucasian copper deposits occur at Belkony and Trombon.

Non-cupreous pyrite deposits are found at Chiragi-Dzor, in the Azerbaidjan province. These deposits are interesting in that plans have been made here for the export of this material which is as high grade as that at the Rio Tinto. These pyrites will also be used by the oil industry at Baku but with completion of the Zangezour metallurgical and acid plants, the production from this district should be made available for export. There is some dissension as to the reserves of this district, which in any case should not exceed several million tons. The deposits are worked by tunnels and connected with the railroad by an aerial tramway. The Trans

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Caucasus copper deposits total approximately 120,000,000 tons ore. (Soviet estimate.)

MIDDLE ASIA REGION

In this region are found the bulk (roughly 65% to 70%) of the copper reserves of Soviet Russia. Some of the principal districts are as follows:

KOUNRAD DISTRICT: This great low grade secondary enrichment, and a similar deposit at Almalyk, are the two great "porphyry coppers" of the Soviet Union. They are similar in grade and kind of ore to the Ajo occurrence in Arizona, and are credited with some 500,000,000 tons ore between them. Polymetallic sulphides are found at Kon-zobal, Gulshad, Kyzl-espai and Akchagyl. A 54,000 ton flotation mill will be erected here in the Kounrad district which will produce 175,000 tons of copper yearly. The task is of proportions almost impossible under the existing conditions of desolation, climate and tremendous natural obstacles but the Soviets are grinding away in this remote desert region on the creation of a railroad several hundred miles long, a townsite for 50,000 people at Lake Balkash and the mining and metallurgical construction at the deposit, on all of which 85,000,000 rubles had been spent prior to 1935.

The BOSHTCHEKUL district which is north of Kounrad and about 85 miles west of Ekibastus contains numerous sulphide copper deposits to which Soviet geologists give a (probably excessive) rating of some 360,000,000 tons ore. The old and well known Spassko-Uspenski copper district which contains more than 50 deposits some of 6.0%

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1 copper ore de, is found in the Kirghiz steppes about 500 miles south of Akmolinsk. A flotation mill and smelter, and sulphuric acid plant, will serve this district, - 3,000,000 tons ore reserve.

DJEZKAZGAN district is to the East of Kounrad and 44[illegible] kms. from station Djusaly on the Turkestan Orenburg railroad. With seven separate ore bearing horizons, and 27 orebodies, this district (in Soviet estimation) runs into some 100,000,000 tons ore. At the present time 5,000 tons of copper a year are produced here but a 15,000 ton flotation mill is well under construction and the old small smelting plant is being considerably enlarged. It is proposed to erect a 150,000 tons per year copper plant here eventually, with sulphuric acid plant.

In SIBERIA there are numerous copper and sulphur pyrite deposits but as they are located some distance from railroad little has been made to exploit them, except at Norilsk in the extreme north western part, near the mouth of the Yenesei River, above the Arctic Circle. Here a good sized sulphide deposit of copper and nickel (regarded by the Soviets as "second Sudbury") is under aggressive development, its importance attested by the fact that its entire smelting is by the G.P.U.

Also above the Arctic Circle, in the Kola peninsula in the northeast corner of European Russia, there are sulphide copper nickel deposits which though not large will be aggressively exploited because of the scarcity of nickel in the country.

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CONCLUSION

[illegible] AND [illegible] DESIRED

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CONCLUSIONS PYRITE AND COPPER DEPOSITS

The pyrite production,-not only of lump "sulphur" pyrite, which will be mined simultaneously with the copper pyrite ore, but the re-flotation of the copper pyrite tailings- constitutes the largest source of raw material for sulphuric acid and elementary sulphur production in the Soviet Union. The pyrite tailings are of course dependent on copper production. Copper production is clearly on the upgrade as the following figures show:

Year	Metric tons Copper	
1933	44,300	
1934	53,300	
1935	71,000 (Plan)	According to first 3 months production, the output this year will be in the vicinity of 77,000 metric tons.

The average grade of ore and the tonnage of ore mined in the same period is as follows:

Year	Average Cu.%	Tons Ore
1933	2.09	1,532,000
1934	2.53	2,167,000
1935	2.3	3,349,000 (Estimated according to current production)

The use of pyrite tailings is increasing in Russia as shown by the following percentage figures of all materials used for sulphuric acid manufacture.

Year	"Sulphur" Pyrite	Flotation Tailings	Coal Pyrite	Metallurgical Operations
1933	56.2%	31.8%	7.5%	4.3%
1934	51.4%	36.6%	7.4%	4.6%
1935	40.4%	42.7%	11.2%	5.7%

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The sulphuric acid production figures during the same period is as follows:

Year	Metric tons
1933	627,000
1934 Plan	870,000: Actual, 782,000
1935	965,000 (estimated according to first 9 months production)

The above tables clearly show that although the use of pyrite tailings has been increasing rapidly, it has not kept pace with their production and it is variously estimated that between two and three million tons of pyrite tailings are in dumps at the present time. In 1937, with a planned copper production of 135,000 tons, - which seems reasonable at the present moment, - and increasing percentages of coal pyrite and sulphuric acid from metallurgical operations, the tailings available for the sulphur industry will be in excess of the demand. Unless flash roasting becomes more popular than it is at present, these excess flotation mill tailings will not present a direct threat to export trade. On the other hand, these tailings will have the tendency to release the lump "sulphur" pyrite which will be mined to some degree at all times, concurrent with copper, for export. The grade of this pyrite compares favorably with that of Spain or any other country. It is also to be noted that these excess flotation mill tailings, if successfully used in the manufacture of elementary sulphur by means of the Ushkevich process will tend to release the native sulphur production of the south for export.

Should an attempt be made on the part of the Soviets to export non-cupreous pyrites, Norway, Cyprus, Portugal and Spain

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will be the losers. France, a larger importer of Spanish non-cupreous pyrites, is discussing new military and trade agreements with Soviet Russia and an attempt may be made to include Russian pyrites in the trade movement. This export of non-cupreous pyrite material is highly probable as it is considered a by-product of copper mining operations in that it is taken out simultaneously with the copper pyrite ore, and as there are large reserves within the Union.

The use of flotation tailings for sulphuric acid and elementary sulphur manufacture will be given added impetus in the near future. This will be due to the appointment of Prof. Ushkevish as Technical Director of the Chemical Trust, during the month of November, 1935. He will undoubtedly show partisanship in the use of this material as he has spent practically all of his recent years in experimenting with it. It is hardly probable, however, that his appointment will result in any stoppage of construction or alteration of plans to use coal pyrites, or of construction at the various native sulphur deposits. Instead he will increase the popularity and use of the pyrite tailings and thus further confuse the sulphur picture. The plan for elementary sulphur production from pyritic tailings in 1937 is 105,000 tons, a Plan figure that may further be increased by Prof. Ushkevich. To accomplish this Plan figure, however, elementary sulphur plants will have to be provided that are 3 or 4 times the total capacity of the existing producers (1935).

The Soviet Government has issued orders that all copper smelters must be equipped with means for manufacturing sulphuric

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acid from the sulphurous fumes from roasting of the copper concentrates. There is little likelihood of this plan being changed and there is no disagreement in respect to it. With increasing copper production there will be increasing sulphuric acid production from this source. The increases in the next few years will be large, as the Blaiva, Kounrad, Karsakpai and Degtiarka smelters are under construction at the present time. In 1937, according to the copper plan, 625,000 tons of concentrates will be roasted.

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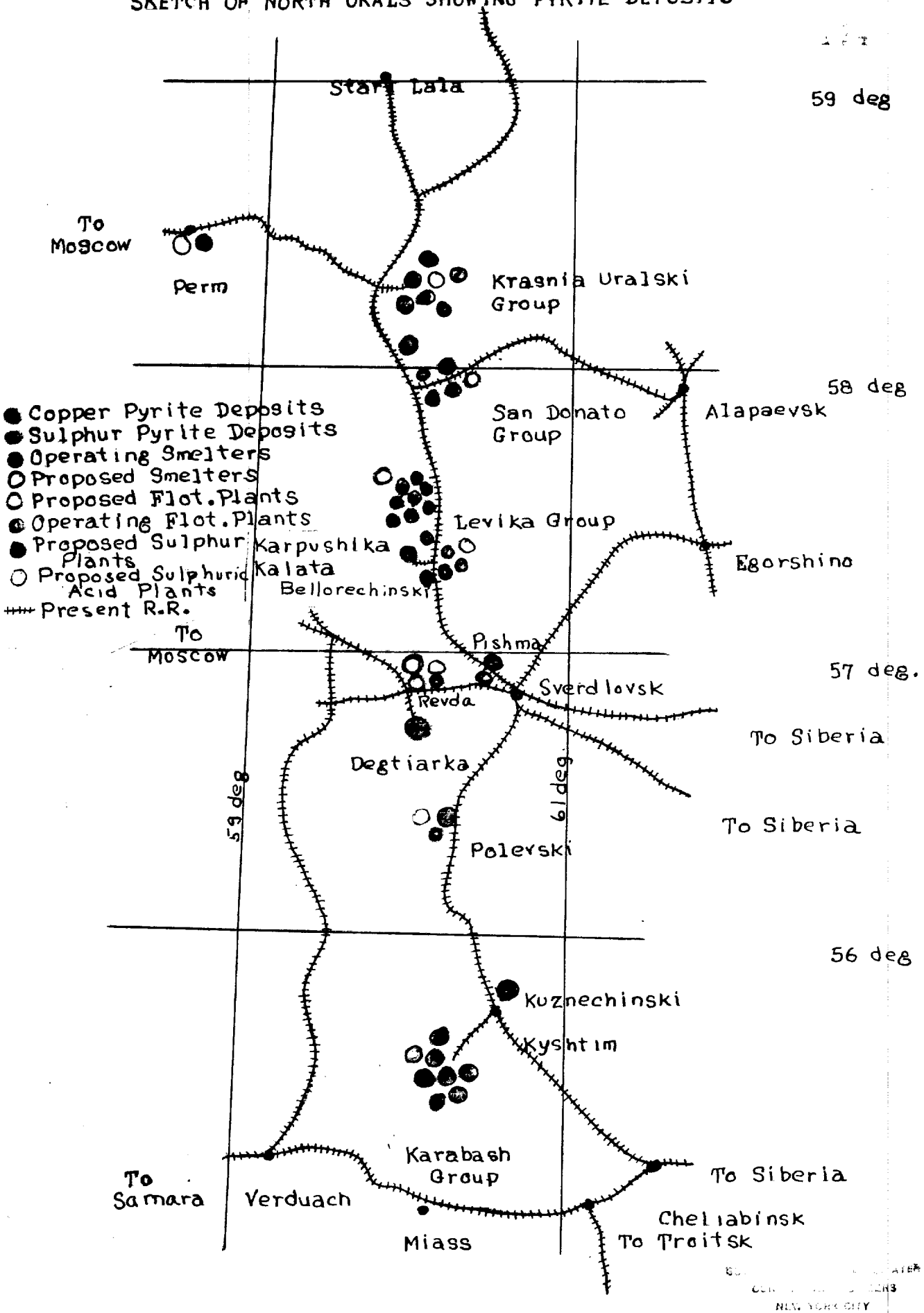
SKETCH OF NORTH URALS SHOWING PYRITE DEPOSITS



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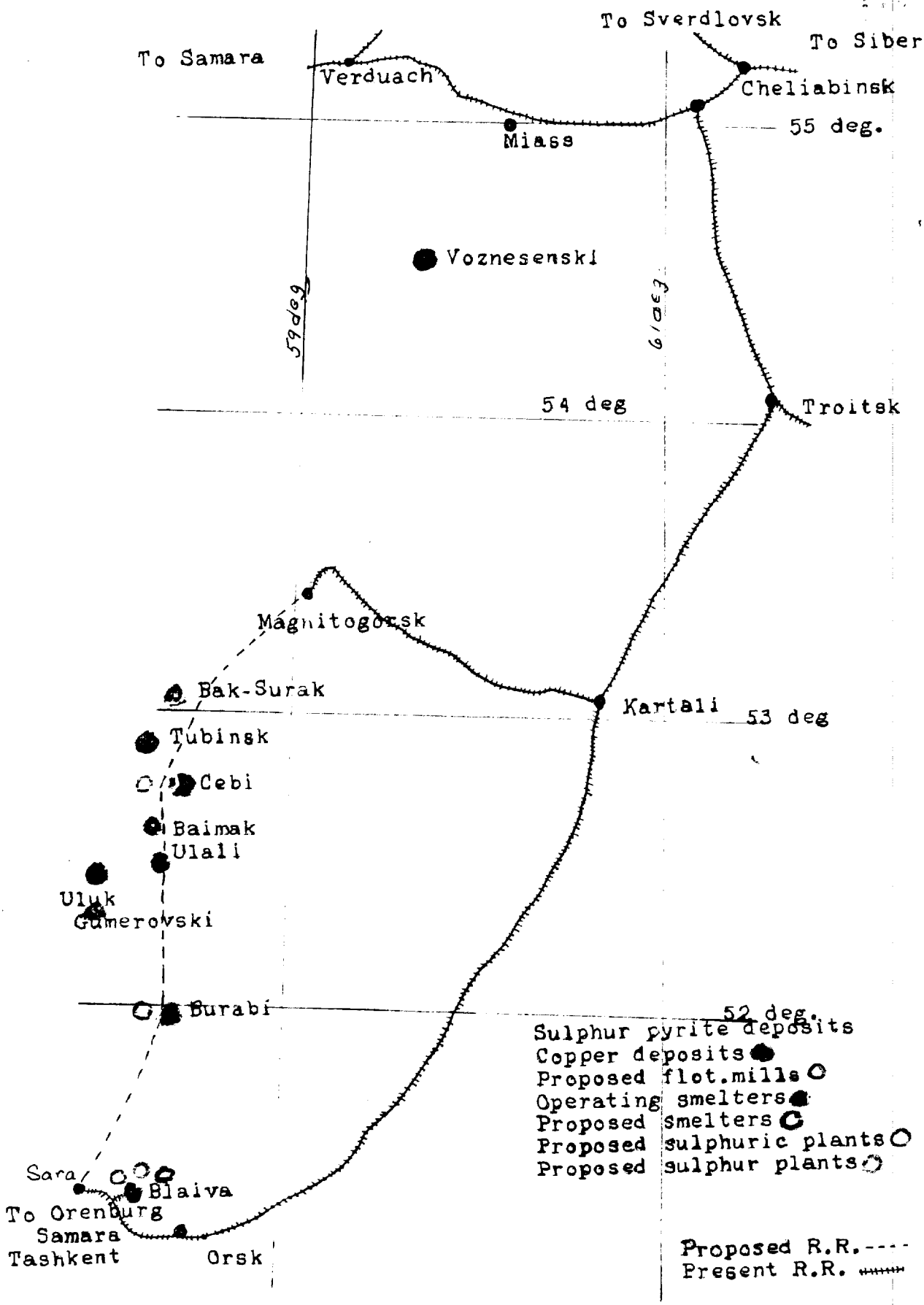
SOUTH URALS SHOWING TYPICAL DEPOSITS



GUY C. [illegible] AND ASSOCIATES
CONSULTING ENGINEERS
NEW YORK CITY

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SECTION
III

MISCELLANEOUS SULPHUR STOCKS

" SULPHUR IN THE U. . . . "

INTRODUCTION
COAL PYRITES
POLYMETALLIC DEPOSITS
GYPSUM
GLAUBERS SALT
CONCLUSIONS

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INTRODUCTION
MISCELLANEOUS SOURCES OF SULPHUR

The Soviets in their attempt to create a sulphur industry have not overlooked any possible source of this material. In addition to the native sulphur and the pyrite deposits as materials for the manufacture of elementary sulphur and sulphuric acid, there are the coal pyrites, sulphurous gases from metallurgical operations in the lead zinc plants, gypsum and Glaubers Salt. Due consideration and experimentation on the part of the Soviet officials have been given to each. In some cases, as with Glaubers Salt and gypsum, no definite decision has been reached as to utilization but experiments along these lines are to continue, by Government orders, until some future date. In the case of coal pyrite and sulphuric acid produced from lead zinc metallurgical operations, these sources are practically assured of a large place in Soviet sulphur production.

Some of these deposits are particularly significant due to their geographical location and may have an important bearing on the future exploitation of native sulphur deposits in the immediate vicinity. Of these various materials, the coal pyrites which are received as a by-product from coal mining in the Don, Kizil (Urals), Caucasus, and Moscow coal basins is the most important, with the sulphuric acid production from lead zinc metallurgical operations ranking perhaps second.

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COAL PYRITES

Don Basin
Moscow Basin
Ural Coal Region

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LOCATION

In the southern European part of the U.S.S.R., in the Don basin and along the northern slope of the Main Caucasus mountain range.

GEOLOGY

Don Basin The coal deposits in this basin are found in the upper horizons of the Middle Carboniferous and lower horizons of the Upper Carboniferous formations. These two coal bearing formations, about 2,000 meters in total thickness, contain about 150 coal seams of which approximately 40 have a workable thickness in some localities. The majority of workable seams of the Don basin have a width from 0.55 to 1 meter. Toward the west, north and east, the coal bearing formations disappear beneath a mantle of Mesozoic and Cenozoic rocks.

Geological and geophysical surveys as well as drilling, in recent years, have shown that the coal bearing formations extend far beyond the previously known limits of the basin, in the direction of Dniepropetrovsk, Kharkov and the Don.

North Caucasus The coal seams in the North Caucasus are found in the Middle Carboniferous formation which has a thickness in these parts of about 400 meters. These coals are in part bituminous and in part anthracite.

Outcrops of Jurassic bituminous coals form a nearly continuous zone along the whole northern slope of the Caucasus range.

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Prospecting has thus far covered only a few of the deposits in Kuban and Daghestan.

Tertiary coals are known to occur practically throughout the whole of the territory of the present Ukrainian S.S.R. The main prospected and mined deposits of Tertiary coal are located in the area on the right side of the Dnieper river basin. These coal seams are of variable thickness - sometimes as large as 20 meters.

RESERVES

Carboniferous Coals

Category A	B + C-1	C-2	Total
34,200,000,000	36,800,000,000	-	71,000,000,000
	Jurassic Coals		
-	200,000,000	-	200,000,000
	Tertiary Coals		
-	-	350,000,000	350,000,000
34,200,000,000	37,000,000,000	350,000,000	71,550,000,000

According to Soviet estimates, the average sulphur content of the above reserves is 2 per cent. In some coal seams the sulphur content reaches to 6 per cent, while the seams used for coking coals, carry as low as 0.36 per cent .

SULPHUR REQUIREMENTS

The use of coal pyrites (obtained by flotation), in the manufacture of sulphuric acid, was objected to formerly by the Chemical Trust due to the admixture of coal in the pyrite product. This caused excessive temperature in the upper part of the roasters

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as well as gas dilution.

In 1930, Kreimer, A Soviet Chemist, started a series of experiments at the "Red Chemist" Chemical plant at Leningrad to determine the possibility and best means of extracting elementary sulphur from this carbonaceous pyritic material. After several years of experimenting with various methods, a small experimental plant was erected in the Don basin. This plant is essentially similar to the Lonmder process in all details.

No plans have been made to increase this plant - at least, no information is available on it - but the officials of the Moscow coal trust have been watching those experiments with avid interest with a view of adopting it to the coals of the Moscow basin.

The Don coal pyrites are of considerable importance. The sulphuric acid plants in the Ukraine district and in the southern part of European Russia up to the present time have depended on the Ural region for raw materials. The cost of transportation of this material was one of the largest items in the cost of sulphuric acid. The new plan to erect sulphuric acid plants near the sources of the raw materials, will bring about a shortage of coal pyrite in the future at those southern sulphuric acid plants. It is therefore important that the Soviets direct attention to the use of these Don coal pyrites.

In this intensively industrialized region there is a large agricultural, chemical and metallurgical demand for sulphuric acid.

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In the rocks forming the Moscow Valley sulphur pyrite is found in nearly all formations from Devonian limestones to Post-Tertiary clays and sandstones. In some parts of this basin concentrations of the pyrite in thin coal seams or in clay found immediately under the Upper Jurassic sediments have prompted the Soviet officials to regard this district as a potential source of sulphur pyrite for the local sulphuric acid industry. The larger concentrations of sulphur pyrite are found in the southern end or lower part of the Moscow basin; smaller concentrations occur in the northern part.

DEPOSITS

The sulphur pyrite[5] in both these sections are found in sandstones, clays, but more often in coal seams either as disseminations or as pockets.

Northern District

The Alexandro-Verski deposit is located near a railroad station of the same name on the Moscow-Kazanski R.R. In 1931 this deposit was prospected by drilling and in 1934 a shaft was sunk and exploratory drifts put out to examine the deposit in detail. The deposit is typical of the Lower Carboniferous coal deposits of this district. The pyrite occurrence is decidedly irregular varying from 0.1 to 0.15 meters in thickness and is as a rule found in coal bearing clays. The plans for mining this deposit are still uncertain.

The coal itself is not minable; therefore, to handle this deposit, for its sulphur pyrite content only, would be expensive;

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preliminary estimates show that a ton of sulphur pyrites would cost 125 rubles. Pyrites from the Urals could be laid down at this place for 30 rubles a ton. Certain Soviet engineers are advocating the utilization of the clays but the Brick Industry has given an unfavorable opinion on its end of this program.

Lower Moscow Basin

From an economic point of view the sulphur pyrite found in this region is important in that it is obtained as a by-product in the coal mining operations carried on here.

In 1934, Soyuzchimruda (South Chemical Ore Trust) and Moscow Coal Trust made a joint investigation as to the possibilities of using sulphur pyrite for the local sulphuric acid industry. After months of investigating they concluded that more consideration should be given this and samples of the coal pyrite culm were sent to the Stalinogorski Experimental Mill. Tests showed that a clean separation could be made from the coal.

Reserves

In the northern part the reserve of the Alexandro-Verski deposit is estimated as follows:

Category B	600,000 tons
Category C-1	700,000
TOTAL	1,300,000 tons

In the lower basin the findings of the joint commission gave the average sulphur pyrite content of the coal beds as 4% of which 2% will be recovered. Therefore, with a Soviet estimate of coal reserves in this district of 1,000,000,000 tons, the estimated recoverable reserves are taken at 20,000,000 tons of sulphur pyrite.

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[redacted]

In 1933 the lower Moscow basin produced 27,[illegible]37 tons of sulphur pyrite. In 1934 the following figures are given for this region:

Pobedinski	11,218 tons of sulphur pyrite
Tovarkovski.	[illegible]
Bobricovski.	2,370
Schenski	7,[illegible]
Swartz	2,440
Cashiriski Flot. Mill.	4,[illegible]
TOTAL. . .	37,94[illegible] tons

In 1935 this figure, according to production for first nine months, should be exceeded by at least 25%.

Some idea of the scope of these operations may be gathered from the local sulphur plans for the future. In 1937 plans have been made to obtain 100,000 tons of sulphur pyrite ore from the Pobedinski, Tovarkovski, Swartz and Schenski plants, 50,000 tons from the flotation plant at the Cashiriski steam electric station and 30,000 tons at the Bobricovski plant.

REMARKS

This Moscow district offers sulphur pyrite and even elementary sulphur potentalities. The sulphur pyrites will be used despite the cheap Ural pyrite with which they compete. The local Moscow engineers are following the experiments in the Donbass coal region where effort is being made to extract elementary sulphur from the coal pyrites.

Unless the experiments prove successful in Donbass the production of sulphur pyrite in this Moscow district will be limited by local demand for the sulphuric acid industry. The coal will always have a sale there because of the huge demand by

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the many Moscow industries. It is therefore highly probable that as the coal pyrites are entirely a by product this district will remain a producer of pyrite for some time to come and in reasonably high amounts.

The management here are making rapid strides toward the better mining and recovery of these pyrites. The district lies close enough to Moscow to compel the Moscow Coal Trust and the Soyuzchimruda to work in close co-operation.

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LOCATION

The coal bearing region of the western slope of the Urals has been traced from the city of Sverdlovsk north to the branches of the Pechora river, a distance of 80 kms. With the exception of the Kizil district, the larger part of this zone is of little commercial importance.

DEPOSITS

The Kizil district has an approximate length of 100 kms. and a width varying from 15 to 20 kms. The workable area within this district is considered as approximately 1440 sq. kms.

The coal seams, 7 to 10 in number, are found in the Middle Carboniferous formations; thickness from 0.8 to 3 meters - occasionally 5 to 7 meters. The pyrite, as marcasite, is found as lenses, nodules, bands and disseminations in the coal. A large number of samples at different places in the Kizil district, show ash, sulphur and moisture contents uniform.

The following table shows the composite of samples taken from the operating mines:

Name of Mine	Ash	Sulphur
Volodarski		
1. Upper Bed	13.21	6.31
2. Middle Bed	17.47	4.89
3. Lower Bed	27.09	5.27
Lenin Mine		
1. Upper Bed	17.34	5.25
2. Middle Bed	17.73	5.52
3. Lower Bed	14.51	4.50
Polovinskash		
1. Upper Bed	23.43	6.92
2. Lower Bed	24.64	7.48

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Name of Mine	Ash	Sulphur
Kubacha Mine		
1. Upper Bed	26.44	6.57
2. Middle Bed	9[illegible].15	6.25
3. Lower Bed	21.70	[illegible].90
Gas Tunnel	18.46	6.62

[illegible]

Category

A	B	C-1	C-2	
101,387,000	647,4[illegible]0,000	1,290,7[illegible]0,000	1,1[illegible]6,103,000	
			[illegible]	3,292,372,000 tons

REMARKS

Although these coals have high sulphur content, and a large amount of sulphur pyrites will undoubtedly accummulate in time to come, it appears from the present attitude of the Kizil coal trust that little will be done about this particular source of pyritic material. The coal trust officials have the attitude that if the Chemical Trust desires this material they are free to come and get it but the coal trust will not burden itself with flotation mills and shipment of the product. The matter stands deadlocked at the present time.

With large quantities of cupreous and non-cupreous pyritic materials being mined in the Urals this coal-sulphur, although large in possibilities from the Soviet point of view, has doubtful commercial importance. There is a lack of good coking coals here.

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Urals
Kuzbass (Altai)
Far East
Caucasus
Western Siberia
Transbaikal
Kazakstan

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POLYMETALLIC DEPOSITS

These deposits are worthy of mention in that the sulphurous gases from the roasting of zinc concentrates are to be utilized, by government order, for sulphuric acid manufacture. In considering these polymetallic deposits no attempt has been made to determine possible production from each district or mine. In general, the lead-zinc deposits, with the exception of the Ridder Mine in Siberia and the Sadon mine in the Northern Caucasus, are numerous but small in extent. Under the mining conditions in the Soviet Union to date, this factor is favorable to production though unfavorable to economy. In Soviet mining practice a large deposit is a handicap to production. Numerous mechanical delays, poor management, lack of co-operation between workers due to the universal contract system, and other similar causes prove more disastrous in a large mine than in several small mines with a program equal to that of the large one.

The large number of small lead zinc mines common in Russia will give ample opportunity for some time to come for the Soviets to perform the program in lead and zinc. The following districts are producers of lead and zinc in the country:

URALS

Very little lead is found in the Ural district but zinc is present in varying amounts in all copper pyrite deposits. In some deposits, the zinc content in the ore runs as high as 17%. All flotation mills in this region are designed to recover the zinc in the ore although in some cases, at the expense of some copper. The zinc concentrates are to be treated in the

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Cheliabinsk electrolytic plant, now under operation, which has an annual capacity of 50,000 tons of metallic zinc.

RIDDER (ALTAI MOUNTAINS)

The Ridder polymetallic deposits are located on the western sides of the Altai mountains in northeastern Kazakstan. This region, long exploited, is one of the richest lead silver zinc gold districts in Soviet Russia. Production at the present time is approximately 1,000 tons of ore daily but within a year this will be increased to 2,000 tons. The lead content of the ore varies from 4.1 to 5.75%, zinc 6 to 10%, gold 14 to 17 grams per ton and silver 30 and 90 grams. A flotation mill and lead smelter serve the district. The zinc concentrates are sent to the Belovo plant which has a capacity of 12,750 tons of distilled zinc annually.

FAR EAST

Of all the numerous lead-zinc deposits known in the Verkhoyansk, Yakutia and Maritime provinces in far eastern Siberia the Tuitiho deposit is the best known and has been exploited for years. Nothing has been done with the other lead zinc deposits although over 300 separate deposits are known. Nearly all of these are small and lie some distance from the railroad. The Tuitiho deposit is located 350 kms. northeast from Vladivostok along the Japanese Sea. The ore consists of chalcopyrite and pyrite with lead and zinc. The zinc contents (ore) are 11%, lead 10% and 250 grams silver per ton. The zinc concentrates are shipped to the Belovo plant (Siberia) and to the Konstantinovski plant in the Don basin. (European Russia.)

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CAUCASUS MOUNTAINS

The principal lead zinc mine in this region is the Sadon mine located 75 kms. east of Orjonikidzi (formerly Vladikavkaz) at which is located the lead and zinc smelter. Sulphuric acid is being produced here at the present time. The Sadon deposit is approximately 2½ kms. in length.

Other lead-zinc deposits are found at Zangezour, located on the Persian border. A lead zinc plant is projected for this district.

Other deposits are the Buron, Karachai, Kvaissia and smaller occurrences. The zinc content in all these deposits is higher than the lead. The zinc contents for the Sadon varies from 16 to 23%, lead 7 to 12%.

SALAIR DISTRICT
WESTERN SIBERIA

These lead zinc deposits are located in the northwest slope of the Salair mountain range in western Siberia. The deposits are found in crystalline Cambrian limestones and are as a rule small in extent. The zinc content of the ore varies from 6.14 to 9.83% and lead from 1.01 to 1.59%. A 2,000 ton mill is projected for this district. The zinc concentrates are shipped to the Belova zinc plant.

NERCHENSK DISTRICT
East Transbaikal Province, Siberia

Between the Shilka and Argun rivers in this province there are 475 known polymetallic deposits. These are confined largely to the eastern part of this district in a limestone area. A lead

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smelter serves this district and the zinc concentrates are shipped to Belova. The zinc content of Nerchentsk ore averages 15%, lead 10% and silver from 150 to 200 grams per ton.

KAZAKSTAN

In this region there are two well known districts containing lead-zinc. They are as follows:

TURLAN deposits consisting of two zones, each about 600 meters in length, are found in limestones about 55 kms. northeast of the town of Turkestan. The average grade of lead in these deposits is 17%, zinc 5%. A large proportion of these ores are oxidized.

KARAMAZAR - The Karamazar district lies 100 kms. southeast of the city of Tashkent and forms the western part of the Fergana mountains. The deposits, South Darbaza, Takeli, etc. are of mesothermal type in limestone rocks. The Tari-Ekan, Chukur, Djilga, etc. are hydrothermal types found in fracture zones in effusive rocks.

Some difference of opinion exists in regard to the reserves of this district but in any case they are considerable and should supply the lead zinc metallurgical plant at Chimkent for some time to come.

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RESERVES OF METALLIC LEAD AND ZINC IN U.S.S.R.
(Metric Tons)

District	Lead A B C-1	C-2	Total	Zinc A B C-1	C-2	Total
Altai	584,000	756,000	1,340,000	1,252,000	1,793,000	3,045,000
SE Kazakstan	414,000	517,000	931,000	464,000	504,000	968,000
Transbaikal	212,000	253,000	465,000	431,000	400,000	831,000
Far East	179,000	117,000	296,000	223,000	152,000	375,000
Salair	35,000	8,000	43,000	325,000	55,000	380,000
Urals	11,000	-	11,000	711,000	394,000	1,105,000
Caucasus	141,000	85,000	226,000	284,000	243,000	527,000
N. Kazakstan	42,000	100,000	142,000	34,000	37,000	71,000
TOTAL	1,618,000	1,836,000	3,454,000	3,724,000	3,578,000	7,302,000

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GYPSUM

The gypsum deposits are (to Soviet enthusiasm) another source of sulphuric acid material. Experiments along lines of German practice in which gypsum, coal, clay, with some additions of slag and sand are heated have been followed for some years at the Leningrad Institute. Preliminary estimates made by the Soviet engineers state that a ton of sulphuric acid can be manufactured at a cost of 85 rubles. As this cost is based on laboratory experiment, little significance can be attached. According to the better Soviet engineering opinion, these experiments are premature but as the Government has given orders that they be continued, large sums will be spent along this line. This work is to be continued until the Third Five Year Plan (1937 to 1942) during which a decision will be made as to the use of this method.

No attempt will be made here to outline the numerous and widespread gypsum deposits. It is sufficient to state that they are found in practically all republics and contain reserves that look foolish, on paper.

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GLAUBERS SALT

(Karabugaz Bay, Caspian Sea)

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GLAUBERS SALT

At the present time the status of the great Karabugaz salt development, in its relation to sulphur, is problematical. The idea of manufacturing sulphur as a by-product from the Glaubers Salt of Karabugaz has had considerable discussion in U.S.S.R. At the moment, (late 1935) an ambitious Chemical Combinate plan handling one million tons mirabilite annually for recovery of some eight products (of which 45,000 tons elementary sulphur per year, is one) is apparently in the lead as to popularity.

Karabugaz Bay, located on the eastern shore of the Caspian Sea, contains practically inexhaustible quantities of Glaubers Salt (Soviet estimate, six billion tons).

In the Karabugaz district the resources include small native sulphur showings, gypsum, phosphorites, manganese, magnesium, bromine, oil on Cheleken Island, clay, sand and building stone - all the prerequisites for the creation of a large industrial center at Karabugaz.

High wind in this vicinity makes mining of the Glaubers salt a difficult task at times as it interferes with sucker and scraping operations in the bay. The importance of this district as a producer of sulphur depends entirely on the method of Glaubers Salt treatment finally adopted. Since 1920 the Soviets have been playing around with plans to develop this deposit. A beginning was made during the First Five Year Plan and the desolate, uninhabited shores of Karabugaz have now been peopled with a town of 15,000 - an electric station, truck gardens, trees, schools, clubs, hospital, motion picture house and the

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ubiquitous "Park of Culture and Rest." In the first 10 months of 1935, 115,000 tons of chemicals and salts were recovered, compared with a production of 42,000 metric tons, all told, up to 1932. A small experimental chemical plant, is located at Karshi, 16 kms. from the Bay and 120 kms. from Krasnovodsk, the port on East Caspian shore.

An experimental LeBlanc plant for soda, and sulphur recovery from the CaS waste, was to have started in 1934 for 2,000 tons soda ash and 800 tons sulphur. The building was ready in May 1934 but equipment and material was not available. The Chemical Trust has been struggling toward the completion of this unit, for on the results obtained from it, the details of the Karabugaz chemical combine were to depend. The first section was planned to turn out 75,000 tons of soda ash a year, by 1937. The possibilities of sulphur production (perhaps 65% of the Sulphur in the Glaubers Salt used) would be really considerable with the LeBlanc process, though its cost was estimated at 100 to 110 rubles per ton of sulphur.

During 1934-35, the Chief Administration of the Chemical Trust had a change of heart regarding the use of the LeBlanc process and the country went Solvay. New plans were drawn for a plant to produce 93,000 tons soda ash and 116,000 tons of ammonium sulphate a year and a second similar plant was projected to utilize the Glaubers Salt of the Kulundinsk steppes.

The Chemical Trust has (late 1935) veered back to LeBlanc however, with "improvements" on the old process, designed to meet the lack of fuel and limestone at Karabugaz, and now the Soda combinate proposes to recover with a "modified LeBlanc" an imposing array of products, including 150,000 tons soda ash,

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32,000 caustic soda, 25,000 sodium sulphide, 1,000 dry ice, 12,500 sulphite, 5,000 hyposulphite, and 45,000 tons of elementary sulphur. Special Claus furnaces treat the hydrogen sulphide, for the last named product. Certain phases of this work were checked at the Konstantinovski Zinc Plant in the Ukraine. A flow sheet of this modified LeBlanc has been published in the Gosplan (and is available) but this Karabugaz project does not impress the writer as yet settled. A large chemical operation will undoubtedly arise here, - definite particulars of process and products remaining uncertain at this writing.

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CONCLUSIONS

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CONCLUSIONS: MISCELLANEOUS SOURCES OF SULPHUR

The coal pyrites in Soviet Russia in the Don, Caucasus and Moscow basin are of some importance. The coal pyrites in the Kizil basin in the Urals are not of as great importance although they contain the higher content of pyrite. The increasing importance of coal pyrites is shown in the following table.

Year	Percentage coal pyrites used to all other sulphuric acid material
1933	7.5%
1934	7.4%
1935	11.2%

In 1937 the planned tonnages of coal ~~mines at~~ in these ~~coal~~ districts are as follows:

District	Tonnage Coal	Ave Sulphur content/ton	Tons sulphur	Tons sulphur Recoverable 50%
Don and Caucasus	70,500,000	2%	1,410,000	705,000
Moscow	10,000,000	4%	400,000	200,000
Kizil	6,930,000	6%	415,800	207,900
TOTAL	87,430,000		2,225,800	1,112,900

As this coal pyrite material is considered purely a by-product material no mining costs are charged against it. Flotation tests show that a clean pyrite material can be obtained at a very small cost, which can be utilized in the sulphur and sulphuric acid industry.

Up to the present time, the larger concentration of sulphuric acid plants was in the southern part of European Russia. These plants obtained the bulk of their material from the pyritic deposits

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of the Ural region. The long transportation haul represented a large part of the total cost of sulphuric acid production. In order to supply these Southern plants with a local source of material, the Soviet officials have recently turned their attention to the coal pyrites near at hand.

As this latter material is available in sufficient quantities (in excess of that required for the local sulphuric plants) it offers wide possibilities. The coal and pyrites supply occurring together in the same district coupled with the fact that there is but little cost attached to these coal pyrites makes a combination resulting in cheap raw material for not only sulphuric acid but elementary sulphur. The Don, Caucasus and Moscow districts are favorably located in respect to shipping ports and are well served by railroads. As there will be an excess of pyrite material over that required by the sulphuric acid industry, this excess gives these deposits added significance.

The sulphuric acid production from the sulphurous gases of the lead zinc metallurgical plants will also show an increase. The reserves of lead and zinc ore are sufficient to supply the Soviets for some time to come and assure the plants a steady supply of this material. All lead and zinc plants are to be equipped to recover the sulphur in the fumes. There appears no dissension to this plan. The lead and zinc production in Russia has been steadily mounting, as shown in the following table:

Year	Metric tons Lead	Zinc
1933	13,700	16,600
1934	28,000	27,055
1935 (Estimate based on 11 mos.)	45,000	46,000
1937 (PLAN)	117,000	90,000

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The average zinc content in the concentrates handled during the same period and the average content of the zinc ore mined is as follows:

Year	%Zinc in ore (all Russia)	% Zn in concentrates from lead-zinc deposits	% Zn in concentrates from Ural copper pyrite deposits
1933	10.9%	44.2%	38.6%
1934	10.35	45.5	41.4
1935	9.91	44.6	45.0

In 1937 the zinc program calls for the production of 90,000 tons of zinc. In that year the average zinc in the concentrates will be lower than that for this year due to the low grade deposits of Middle Asia coming into production at that time. Assuming a 45% zinc in the concentrates about 220,000 tons of concentrates will be handled.

The gypsum deposits at the present time do not offer a serious source of sulphuric acid material. In some districts, where there is a good demand for acid and a shortage of pyrites or sulphur exists, it is possible that gypsum may be used. Until the Third Five Year Plan, and even then, it is doubtful that this material will have an economic importance. Nevertheless experiments will be continued along these lines.

The Karabugaz Bay Glaubers Salt industry, - if the Solvay process were to be adopted, - would be practically eliminated from the sulphur and sulphuric acid picture. Continuous experimentation at the small test-plant at the Bay has, however, (1935), reached a point from which the Chemical Trust is advocating a modified Leblanc procedure of most ambitious proportions.

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It is proposed that the combinate treat 1,050,000 tons of mirabilite per year, turning out among some eight by-products an elementary sulphur tonnage of 45,000. This is but the most recent plan developed in the Soviet chemical attack on Karabugaz salt - it may or may not be followed by another swing to Solvay. Only the future will disclose the actual treatment that is to go in here.

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SECTION IV

ECONOMIC FACTORS

"Soviet Russian Sulphur"

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Change in Trend

Within the past two years both the economic and political picture in Soviet Russia has greatly, very greatly, changed. The present political trend is toward a more democratic pattern of Communism, which if continued, augurs well for the future of Russia. While it is well-nigh impossible to make predictions regarding economic conditions in a country ruled by a dictatorship, it appears that even further concessions will be made by the Soviet officials to the people. The large industrial gains made within the past year can be traced to this Leftist movement rather than to any other factor and these gains will not be overlooked by the present government officials. The people are more in accord with the Soviet Regime at the present time than during any period since Stalin's rise to power.

The material in the preceding pages undoubtedly offers a dismal picture of low grade native sulphur deposits, poor transportation facilities, remote localities, and other difficulties attending their exploitation. In practically all cases, with the exception of sulphuric acid produced from pyrites and from gases at the zinc and copper plants, production costs will be so high as to make one wonder if it is economically possible to continue these plans. Close analysis of Soviet plans regarding other sulphur resources show that these are also economically unsound but nevertheless they are continuing with them. Behind all Soviet planning is the aim of freedom from foreign imports and the establishment

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of industries capable of supplying national needs; the Soviet officials are entirely cognizant that many plans will fall short of outside economic standards.

The World War proved the easy manner in which Russia, with a lack of adequate rail transportation facilities and year around ports, could be cut off from foreign supply sources. It showed the Soviet Government that despite enormous manpower, the country was pitifully weak because of its lack of industrialization and economic sufficiency.

U. S. S. R. could easily and effectively concentrate attention on agriculture, fishing, lumbering, and other abundant resources and pay less attention to the manufacture of commodities that can be cheaply purchased from abroad. This would have resulted in a stronger financial position and less hardship on the people (the Protzary Program), but it would be, they believe, at the expense of industrial and national security. It is for this reason that production goals although given due consideration, are placed in a secondary position to the need. Sulphur given a war-material rating, and information concerning it being treated as a military secret, will be given preference over other commodities not enjoying this rating.

In Russia today there is a strong movement started, by economists and politicians alike, towards stabilization of the currency and to place it in international exchange. The "gold" reserve figure of 397,000,000 dollars on April 1st, 1935, is not entirely a "gold" reserve inasmuch as it includes silver and platinum figured on a gold basis. Nevertheless, the Soviet

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metal reserve is high and is going higher. Imports have been cut to a bare minimum (although still widely needed) and foreign debts have been practically wiped out. Still more recent evidence of a trend toward stabilization is shown by the recent governmental decree to close all Torgsin stores, Feb. 1st 1936, and stabilize all foreign currency within the country at a rate of five rubles to one dollar. Although Soviet economists and politicians are urging the placing of Soviet currency on the international money market, it appears that there is little likelihood that the currency issued to the people will ever have an international exchange value. A plan similar to that used by Germany -(several categories of currency for export trade, internal trade and special accounts)- may conceivably be adopted by the Soviets. High production costs and living costs give the internal ruble an inflated value which if it be allowed to enter international exchange would either wreck Soviet Russia financially (if an attempt be made to stabilize it) or cause cessation of the many unsound economic plans within the country.

Up to the present year Russia has been an importer of sulphur. The following figures show the import of that material:

Years	Tons
1924	2,431
1925	6,743
1926	6,780
1927	8,807
1928	16,503
1929	10,208
1930	21,146
1931	16,181
1932	6,946
1933	1,367
1934	4,233

(1) Another consular report gives 22,346 tons
(2) Other consular sources give 3,012 tons

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According to Consular Report No. 840*

"During the first six months of 1935, presumably because of more intensive exploitation and because of the addition of the Alexsievo (Middle Volga) plant to those actively operating, the exports of sulphur from the Soviet Union increased to 9 metric tons (one half metric ton in 1934) valued at 1000 gold rubles, while the imports dwindled to only 20 tons, likewise valued at 1000 rubles."

Although statements are made from time to time by irresponsible Soviet Engineers as to the possibility of Russia entering the export sulphur market, this thought has not been expressed by any reliable people connected with the industry. Nevertheless, one important conclusion can be reached in this respect: in 1938 or 1939 there are possibilities, if present Soviet sulphur and sulphuric acid plans and construction continue by both the Non-Ferrous Metal Trust and Chemical Trust, that production will greatly exceed consumption. The excess will undoubtedly find its way into the export market. Its prices will, in such case, have no traceable relation to actual Soviet costs of production.

STAKHANOV MOVEMENT

This recent piece of labor-exploitation strategy from the

* This Consular Report (instigated personally by G.C.R. in Moscow in August, as one of many disguised moves toward ascertaining actual 1934 production and other unpublished figures on the sulphur industry) is typical of the uncertain and messed-up information that is offered in U.S.S.R., and out of it, on Soviet matters. The American Embassy, eager to help in any way within its power in Moscow, sent a personal representative to the Commissariat of Heavy Industry, and there obtained useful bits of information from the Sulphur Trust Officials at my request. This "Consular Report" was then prepared, during my absence at Samara, Mid Volga, and presented me on my return as an answer to the questions I had asked of the Commercial staff. It originally contained definite mis-statements that I caused the Embassy to remove, but it was nevertheless transmitted to the State Department with other obvious errors on which I had also advised correction. The above values of export and import sulphur, and the effect of any 1935 production in the Middle Volga on export of the Soviet commodity, are obviously incorrect.

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20/ Kremlin is of definite significance in the Soviet economic position. In itself nothing but the ordinary rationalization of labor and equipment that has prevailed for years in capitalist industry, it is bound to powerfully increase output in all lines of Soviet production. There is absolutely nothing new about this "method" labelled with the name of Alexei Stakhanov (an alert, illiterate, record-breaking coal miner of the Donbass region,) but it has been seized upon inside U.S.S.R. as a new "ism", a slogan or drive of the Kremlin toward greater industrial production. Norms of output per worker and total yearly tonnages of commodities from soup to nuts will in all probability be revised upwards some 25%, (not yet settled) for 1936, and as in the former major economic movements of the Soviet dictatorship - "liquidation of Kulaks" and "collective farming", "Five Year Plans," "Udarniks (Shock Brigades), "social competition," - it will be mercilessly pushed into the lives of the workers. Soviet labor nonchalance and general lassitude is always in need of the spur, and in one form or another it is going to get it. At the present moment in Soviet history, with the really enormous strides ahead that have been taken during 1934-35 into greater personal comforts (clothing, food, lower prices) for the people, this much acclaimed Stakhanov Movement is definitely required in U.S.S.R. to take up the slack, and drive production on and up. This it will unquestionably do. It will at the same time, act as a cut in wages to the average workman, with a few leaders and zealots out in front earning higher wages by super-effort.

CONSUMPTION-No figures are available for future sulphuric acid or sulphur consumption in the Soviet Union by individual consuming

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industries, and if these were undependable, no reliance could be placed upon them. The Soviets are silent, in cases of a shortage of a certain commodity, to direct its flow to that industry which has the greatest importance. In addition, confusion regarding sulphur and sulphuric acid plants, the present period of parallel construction and the lack of materials, such as zinc, in some sulphur-consuming industries, make any figure on consumption unreliable. In many lines of Soviet industry, however, should industrial plans continue to forge ahead, there exists a tremendous demand for sulphur. In some industries - as for example, the pulp and paper, fertilizer, metallurgical operations, iron and steel, chemicals, textile, explosive and coal products - the future consumption of sulphuric acid and sulphur should compare with, perhaps exceed, U.S. consumption. Paint, rubber and petroleum consumption of sulphuric acid should fall below ours. A brief description of the plans and past performances of the various sulphur-consuming industries are given in the following:

PULP AND PAPER

Russia, with a large supply of pulp timber, has not been blessed with good water power sites. This industry should increase its production to a large extent and its expansion will gradually grow eastward to Siberia where large timber supplies and water are available. There is a huge demand for paper in Russia, - in actual fact, a paper famine has been in existence since the inception of the Soviet Regime. It is not probable that Russia will have a per capita consumption of paper as large as in

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the U.S. but with a large supply of pulp timber, and European and Asiatic markets on hand, the Soviets will enter the export market with this commodity. Production figures of newsprint are given in the table below:

Actual Production		Planned Production	
Year	Tons (metric)	Year	Tons
1933	499,200	1935	620,000
1934	594,500	1937	974,000

The planned production of paper will come from the following districts in 1937.

District	Tons (metric)	Kind of Sulphur Material
Leningrad	186,000	Pyrites
Karelia	75,000	Pyrites
Northern Europe.Russia	45,000	Pyrites
Moscow	12,000	Pyrites
Ivanovski	11,000	Pyrites
Gorki	165,000	Pyrites
West Siberia	56,000	Pyrites
Sverdlovsk	137,000	Pyrites
Middle Volga	19,000	Pyrites
Black Sea	13,000	Native
East Siberia	60,000	Pyrites
Ukraine	31,000	Native
White Russia	54,000	Pyrites
Caucasus	27,000	Pyrites
Uzbekistan	5,000	Native
Turkmeinia	2,000	Native
TOTAL	981,000	

The officials of the paper and pulp industry are protesting against the use of pyrites in their industry and have demanded native sulphur. There is little possibility of the latter, as the Government has ordered the use of pyrites and the installation of flash roasters, with a few exceptions as noted above, throughout the paper industry.

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RUBBER INDUSTRY

This industry due to the increasing number of trucks and automobiles in Russia, the dire need of rubber shoes, and the considerable lack in light rubber goods, should consume increasing amounts of sulphur in the near future. The growth of automobile production is shown by the following figures:

Year	Number of Cars
1933	49,700
1934	72,500
1935	92,000 (planned figure will be exceeded)

In 1940 it is estimated that 200,000 tons of rubber for domestic needs is a conservative estimate. This figure largely depends on the Soviet ability to accomplish the proposed increase in service of their tires from an average present mileage of 22,500 kms. to 50,000 kms. If this is not accomplished, however, the Soviets estimate that rubber consumption for that year may reach the figure of 400,000 tons of rubber. Synthetic rubber is expected to play an important part. The production of synthetic rubber during 1934 amounted to 16,000 tons; during 1935 it will be slightly in excess of 25,000 tons; in 1940 it is planned to obtain 40,000 tons from this source. The present rubber production goes mainly to two lines - rubber shoes and automobile tires. The production figures for these items in the past two years are as follows:

Year	Rubber Shoes	Tires
1933	62,200,000 pairs	679,100
1934	65,000,000 "	1,442,800

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The following figures give this year's plan and that for 1937:

Year	Rubber Shoes	Tires
1935	75,000,000	2,000,000 (both plans exceeded)
1937	110,000,000	6,000,000

Synthetic rubber is being produced in the Ivanovski district near Moscow and a plant is under construction at Erivan, near the Turkish border to produce a new kind of synthetic rubber called "Sovpren." The rubber tire plants are located at Ivanovski.

TEXTILES

This industry also should grow by leaps and bounds in the near future as there is a huge demand for all kinds of textiles and the Soviets have given the business a great deal of attention. The natural expansion of this industry will be toward Middle Asia where cotton cultivation is planned on a large scale. In addition to the cotton, the bulk of the wool and linen also comes from this region. The textile plans and production is as follows:

Textile Production
(in square meters)

Year	Cotton	Linen	Wool	Rayon
1933	2,736,900,000	137,100,000	86,600,000	26,000,000
1934	3,059,200,000	192,000,000	71,900,000	30,800,000

Planned Textile Production

Year	Cotton	Linen	Wool	Rayon
1935	3,800,000,000	230,000,000	72,800,000	34,700,000
1937	4,499,900,000	600,000,000	220,000,000	

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:09 The planned textile production in 1937 will come from the following districts: (in square meters)

District	Cotton	Linen	Wool
Leningrad	250,400,000	23,000,000	6,000,000
Moscow	2,124,500,000	18,000,000	93,200,000
Ivanovski	1,796,400,000	300,000,000	1,100,000
Western Siberia	40,000,000	24,000,000	9,600,000
White Russia	11,000,000	63,000,000	300,000
Ukraine	10,000,000		22,000,000
Saratovski	26,600,000	-	10,000,000
North Caucasus	1,000,000	-	-
Trans Caucasus	100,000,000	-	2,700,000
Uzbekistan	120,000,000	-	-
Turkmeinia	10,000,000	-	-
Tadjikistan	10,000,000	-	-
Gorki	-	62,000,000	1,000,000
Western District	-	60,000,000	9,000,000
Tatar Republic	-	17,000,000	400,000
Middle Volga	-	10,000,000	24,000,000
Sverdlovsk	-	12,500,000	3,300,000
Cheliabinsk	-	3,500,000	1,000,000
Bashkiria	-	-	1,100,000
Kazakski	-	-	8,300,000
Eastern Siberia	-	-	700,000
Azov Sea	-	-	14,800,000
Black Sea	-	-	11,500,000

The Moscow, Ivanovski andGorki districts as can be seen from the above table are the principal textile centers in Russia, and as they lie in the Moscow basin added significance can be given to the Moscow coal pyrites as a source of sulphuric acid for this industry.

PETROLEUM

The petroleum industry in Russia will be compelled to meet steadily increasing domestic demands, especially for the refined products gasoline and kerosene. A large increase in oil production is necessary to meet this and additional refinery capacities must be introduced. While an increased Soviet oil production is possible by the addition of new oil equipment,

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it is to be remembered that the Russian fields have had a long history of production. Recent drilling in the Baku and Grozna fields has not been as productive as it has been in the past. An increasing demand in refined petroleum products will necessitate increasing demands for sulphur. The Baku and Grozni fields on the west side of the Caspian sea have two sources of sulphur material - the sulphuric acid from Allaverdi, Zangezur and Orjinkidzie metallurgical plants and from pyrite deposits located in the Trans Caucasus - or from sulphur recovered as a by-product at Karabugaz Chemical plant which is located on the eastern shore of the Caspian Sea. The Middle Asia oil deposits will be well servedby the native sulphur deposits lying in close proximity to the oil fields. The following table gives the oil production figures for the past two years.

Year	Oil (in metric tons)	Gasoline	Kerosene
1933	22,394,000	2,655,000	3,867,000
1934	28,645,000	3,000,000	4,964,000

The planned production figures are as follows:

1935	30,330,000	3,170,000	4,750,000
1937	46,800,000	8,200,000	7,500,000

The planned production of oil in the year 1937 will come from the following districts:

District	Tonnage (metric tons)
Azov - Black Sea District	1,800,000
N. Caucasus (Grozni, Markop)	9,750,000
Bashkiria	1,350,000
Kazakski	1,700,000
Far East	800,000
Trans Caucasus (Baku)	29,950,000
Uzbekistan	350,000
Turkmenia	1,100,000
Total	46,800,000

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FERTILIZER

With a population, and a hungry one at that, variously estimated at 165 to 180 million people, the demand for foodstuffs should greatly exceed our own demands. During recent years due to failures in the sulphuric acid industry and also lack of co-operation on the part of the Non-Ferrous Metal Trust, there has been a shortage of artificial fertilizer. According to present plans the quantity of artificial fertilizer per square hectare planted will be increased to a large extent as is shown by the following planned figures of super phosphates and for acreage under cultivation during the year 1937. The phosphate production figured on a basis of 14% super phosphate is as follows:

Year	14% Super Phosphate production (metric tons)	
1933	708,400	
1934	900,000	
1935	1,200,000	(planned production)
1937	3,000,000	(planned production)

The area under cultivation is as follows:

Year	Square hectares	
1933	129,693,000	
1934	129,730,000	
1935	131,184,000	)planned)
1937	139,740,000	(planned)

The following figures show the districts which will be under cultivation as planned for 1937.

District	Square hectares under cultivation
Northern European	1,094,000
Karelia	67,000
Leningrad	2,146,000
Moscow	5, 894,000
Ivanovski	2,256,000
Gorki	6,359,000
Central Black Soil	11,018,000
Tartar	3,250,000

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District	Square hectares under cultivation
Middle Volga	10,255,000
Saratovski	5,151,000
Stalingrad	4,137,000
Azov Sea	8,526,000
North Caucasus	4,135,000
Crimea	950,000
Sverdlovsk	2,680,000
Cheliabinsk	4,484,000
Irtish	240,000
Bashkiria	3,326,000
Kazak	5,610,000
West Siberia	7,092,000
East Siberia	2,092,000
Yakutia	68,000
Ukraine	26,438,000
White Russia	3,983,000
Trans Caucasus	2,585,000
Uzbekistan	2,420,000
Turkmenia	426,000
Tadjikistan	779,000
Kirgiz	1,036,000
Karakalpak	118,000
Western district (European)	4,869,000

PAINTS, VARNISH AND PIGMENTS

Production from these industries has been curtailed due to a lack of materials such as zinc, etc. There is a large and increasing demand, and there are several large plants which have remained idle a large part of the time. With increasing production of zinc and other materials, this industry will soon be a large factor in sulphur consumption. The demand or output from this industry will never exceed that of the United States due to the prevalence of log cabins throughout Russia rather than the frame type of construction. The industrial demand will be large.

DYES AND COAL TAR PRODUCTS

The demand for sulphur in these industries is substantial and will increase greatly within the next few years. The following

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figures show the production of dyes in the Soviet Union during the past few:

Year	Metric Tons
1933	16,000
1934	24,000
1935	23,600 (figure exceeded)

EXPLOSIVES

While no figures are available in this branch of industry, it is safe to say that the military demand will exceed ours and industrial demand should also be very high. The consumption of explosives in mining will not equal that used in the United States but in railroad and road building there should be a huge demand.

IRON AND STEEL

Very little sulphur or sulphuric acid is consumed in this industry at the present time although there has been large increase in this demand. The Soviets due to a lack of materials, as tin, zinc and others used in the galvanizing, tinning, and enamelling of steel products, have not accomplished much in these lines but have concentrated their attention on heavy steel products. The demand along these lines of galvanized, enamelled and tinned products should eventually come close to that of the United States. The Ural iron and steel center will be easily supplied with sulphuric acid and zinc from local sources. The Kuznetz metallurgical center in Siberia will also be supplied from Siberian zinc and sulphuric acid sources and the Krivoy Rog basin from either Middle Asia or Caucasus sources. In all cases the source is not far distant.

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OTHER METALLURGICAL OPERATIONS

Leaching operations will be an exceptionally large consumer of sulphuric acid in Russia, and will according to plans considerably exceed the U.S. consumption in this respect. Large quantities will be used in extracting the nickel from the iron nickel deposits of the Nelka river and Chalilovski (Khalilovo) districts. Still other large quantities will be consumed in leaching operations in the copper industry.

CHEMICALS AND DRUGS

On a per capita basis, the Soviet demand in these lines should exceed the U.S. by 50 per cent, - therefore 50 per cent more sulphur should be consumed in these branches.

TRANSPORTATION

The transportation factor in the native sulphur or pyrite industries in Russia will not play as important a part as it does in the United States or Canada. Although these Soviet

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deposits in the main are located some distance away from the shipping ports, the internal transportation cost has little significance in handling exportable material. Cheap external transportation to foreign countries is realized by means of the Sovtorgflot, (Soviet Trading Fleet) small vessels which ply in increasing numbers between Soviet and foreign countries. Regular Soviet lines (the Baltic and Black Sea) now work the Hamburg-London, and Constantinople-Piraeus-Jaffa trade, and a Far Eastern line operates between Vladivostok and Shanghai. Periodical voyages are made to Swedish, Dutch, Belgian, Italian, French and American ports. Soviet ocean tonnage (some 350 ships, 1935) is now approximately 1,400,000; by purchase, and home construction at Baltic and Black Sea ship-yards, they are gradually building back to their former fleet, once 900 ships.

For movement of commodities inside Russia, the 60,000 miles of Soviet railways (175,000,000 population) compare pitifully with the 300,000 miles in use by 127,000,000 Americans, but the inland waterborne shipping of U.S.S.R. is rather more impressive. It has moved up from 18,000,000 tons of freight in 1928 to 52,000,000 in 1934, with 91,500,000 as the planned figure for 1937. The 75-mile Moscow-Volga Canal (begun in 1933, to be completed 1939) and the Volga Don Canal (1935-1940) are stupendous transport undertakings that will completely transform the internal and substantially re-align the external traffic of U.S.S.R. The Moscow-Volga System - an earth-removal job comparable with the Panama Canal - will, on its completion, relieve the overburdened

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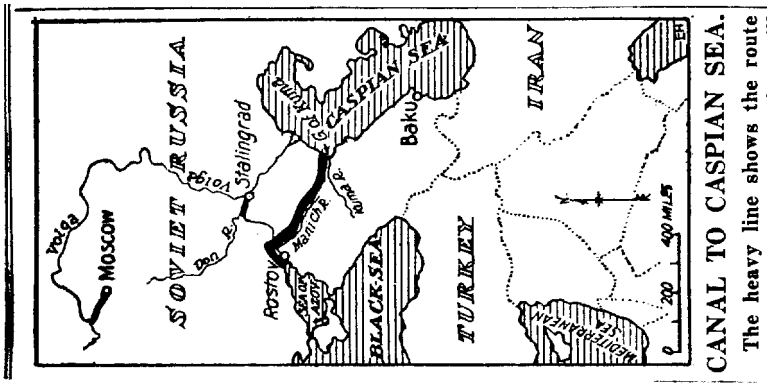
railroads of heavy movements of scores of basic commodities to and from the North, East and South. The further linking up of this Volga-Moscow system with the River Don by the Volga-Don canal, at a point near Stalingrad where these two great rivers converge to within 60 miles of each other, provides (1940) an outlet for heavy water-borne tonnages from all European Russia to the Black Sea and Mediterranean,--oil, potash, phosphates, grain, food-stuffs, lumber, chemicals, ores and whatever else may be produced of exportable status.

By virtue of the recently completed White Sea-Baltic Canal and the tying in of these two great river systems it will be possible, in 1940, to go by ship from the Arctic Ocean to Persia and from Leningrad to Constantinople through the heart of European Russia.

Work has just begun on a third great canal, 400 miles long, to link the Caspian and Black Seas,--opening up the Caspian to ocean-going ships and providing ocean shipment for Baku oil and products from the Middle Asian regions east of the Caspian. This new canal will be an integral part of the co-ordinated systems of inland waterways Soviet Russia is building to augment its railroads and provide cheap transportation in all parts of the Union. The relation of these three new systems is shown on the accompanying sketch.



CANAL TO CASPIAN SEA. The heavy line shows the route of the Soviet waterway that will open this inland body of water to ocean traffic. The Volga-Don and Moscow-Volga Canals, also under construction, are likewise indicated.

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SECTION V

SUMMARY

AND

CONCLUSIONS

"Soviet Russian Sulphur"

Summary Table I - Native Sulphur Deposits
II - Estimated Pyrite Reserve, Urals
III- Estimated Pyrite Reserve Other Than Urals
IV - Planned Mining, Smelting, Acid and Elementary Sulphur Production for Urals District
V - Estimated Probable Productions

General Map

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SUMMARY AND CONCLUSIONS

The Soviets will, in all probability, continue, regardless of the uneconomic production costs and despite natural obstacles, to create an extensive sulphur industry. The present parallel planning and construction of sulphur and sulphuric acid plants is likely to go on until such time as the Soviets realize that they have heavily overbuilt and that consumption is falling considerably below the capacities of the producing plants. The period in which this is due is between the years 1938 and 1940. In this period many large metallurgical plants, native sulphur deposits and elementary sulphur plants will come into production.

According to government orders all metallurgical plants are to be equipped with means to recover sulphuric acid from the fumes. Russia with a predicted copper demand of 400,000 tons annually and of zinc about 300,000 tons would, if it ever reached these copper zinc productions, - which it probably will not - recover a large quantity of sulphuric acid from smoke. The threat is there, however, and the regime has an uncomfortable way of coming through with tonnage plans that appear fantastic to the more experienced outsider. In some instances these metallurgical plants are so located that they will compete with the native sulphur deposits in their immediate vicinity and thus release the production from latter for export or for use in other districts.

The pyrite deposits of the Urals are viewed in Soviet economy

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as the great primary source and base of the sulphur industry. With increasing copper and zinc production, there will be continuous expansion in the production of flotation tailings, which are to be utilized both for sulphuric acid or for elementary sulphur. Due to the sulphuric acid recovered from metallurgical operations and from coal pyrites, it seems fairly apparent that there will be a considerable excess of acid. The recent appointment of Prof. Ushkovish to Technical Directorship of the Chemical Trust will give added impetus to the use of re-flotated tailings as a source of elementary sulphur. Plants are to be erected at several points, - Degtiarka, Krasno Uralsk, Blaive - and already exist, in operation, at others - Kalata, Polevsk, Perm.

The use of coal pyrites, which are recovered as a by-product material, is also of consequence, in that increasing amounts of this material will accummulate with increasing coal mining operations. A good clear pyrite concentrate can be obtained by flotation which can be used for acid manufacture but the demand for this is limited and the coal pyrites will exceed the amount needed. The proximity of the coal pyrites and the coal and the relative cheapness of both, make this a real source of material for elementary sulphur manufacture under Soviet policy. The determined experiment with the flash-roasting elementary sulphur system in the Urals is a matter to watch, as the successful use of this system would be extended to the Moscow basin coal deposits. Both the Moscow and Don coal basins are favorably located in respect to inland waterway shipment to foreign markets.

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The native sulphur deposits are in reality the poorest source of sulphur in Russia. They are low grade and will be high cost producers even in comparison with such by-product materials as coal pyrites and flotation mill tailings. Nevertheless, construction work is well under way and their exploitation will continue. There is, in U.S.S.R., a basic determination to spread productive industry into all parts and sections of the Union, notwithstanding the enormous geographical extent of Soviet territory. Neither climate, distance nor cost stops this penetration - wherever they locate a resource they go after it. This native sulphur production will, to some small extent, be available for export, in view of the large (probable) production of elementary sulphur and sulphuric acid in other sections of the country.

The use of flotation mill tailings for the sulphuric acid industry will release large amounts of lump non-cupreous pyrite which will be mined for some time to come. As this material compares favorably in sulphur content with the Spanish pyrites it may also be a factor in export trade.

One angle of the Soviet economic picture has changed very materially in the last year or two, in a way that is likely to affect somewhat profoundly the relation of Russian commodities to world trade. Soviet gold production (including recovery from private hoards) has in a steady, rapid climb from 5½ million dollars in 1928, reached some $200,000,000 a year in 1935.

In annual ounces now approximately double the United States 1934 production of 5,100,000, it is about one-half of the leading

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221 South African yearly output of 11,000,000 - and its climb is by no means over. For a few more years at least, the Soviets will probably continue virgin gold output from their Ural and Siberian mines in excess of $300,000,000 ($35.00 basis).*

This heavy gold production and the recently acquired ability of Soviet industry to manufacture a large proportion of its equipment needs in heavy and light machinery of every description, plus the fact that economy of import is still rigidly practiced, has enabled U.S.S.R. in the three years just

* Long-term continuance of this dollar value of Soviet gold output rests largely on two factors whose future is beyond the knowledge of man: namely, our own economic gyrations in U.S.A. and the Soviet gold asset itself. It is to be observed that both U.S.S.R. and So. Africa are frantically taking the metal out of one deep hole in the ground abroad so that it may steadily be buried in another deep hole in U.S.A. The uncertainties attending these pseudo-economics, and the indefinite nature of the Siberian metal reserve itself, make prediction unwise beyond a comparatively brief span of years. Hailed at Moscow as certain to shortly overtake African output, Soviet gold production and reserves are in reality conjectural. A sharp fade-out is a possibility, once the remote placer deposits are fully opened up. It is possible that the unmined reserves do total upward of a couple hundred million ounces as claimed in some Soviet quarters - but actual knowledge of the Siberian fields is to some extent a matter of assumption that grades encountered to date will be maintained over extensive areas of identical geologic nature still to be worked.

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past (1933-34-35) to roll up a foreign trade balance totalling 450 million rubles in the black,-150,000,000 ruble average per year. As 1935 closes, the total foreign trade indebtedness of the Soviets - at its maximum, (1931) 1,400 million rubles - has been reduced to approximately 100 million. A very great alteration is thus appearing in the Soviet Russian financial and trade picture,-that this will be accompanied by a lightening of the Soviet pressure of export is to be expected in some degree. An easing off on some of their more extreme efforts at production will probably come about in due course. When, and to what extent, if ever, this will affect the momemtum of military industries like sulphur, is anybody's guess. This enormous gold balance is distinctly a new trend, however, and I can do no less than point out that its persistence may conceivably diminish the Moscow urge to pour Soviet assets out into the world markets from natural resources not truly competitive.

Finally, in a word, an over-expansion may be looked for in Soviet sulphur and acid production that will begin to show up in commerce about 1938 to 1940, with the possibility of both non-cupreous pyrite and native sulphur appearing for export in fairly substantial quantities. It is fairly obvious, however, that only by a continuing scrutiny of the Soviet scene - as the experimental, construction and operating plans outlined in this survey take definite form in the years 1936-37-38 - can the prospective Soviet Russian sulphur balance be quantitatively gauged.

The sulphur position in U.S.S.R., present and prospective, has been reduced to such figures as the existing Soviet situation permits, in Tables I to V, immediately following.

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TABLE I. SOVIET NATIVE SULPHUR DEPOSITS AND PRODUCTION

Area	Location	Metric Tons Reserves	% Grade	Mining Method	Treatment	1934	1935[a]	Estimate Probable	Estimate Possible Maximum	Remarks
Alexiev Vodina	Middle Volga	1,250,000: 2,400,000:	9.8-11.	Open pit	Flotation & autoclaves		1,500	75,000	200,000 to 400,000	Important because of geographical location. 200,000 tons probable ultimate.
Gurdak	Eastern Turkmenistan	[illegible] 2,500,000	10. to 20	Open pit	Flotation & autoclaves (mill surpass	1,500	1,500	50,000	50,000 to 200,000	Important on account of size, flotation results, etc. in same deposit. 50,000 tons probable.
Kara-Kum	Central Turkmenistan	1,140,000 [illegible]	30 to 40	Open pit	Flotation & autoclaves	1,000	1,500	no figure	100,000	Important on account of high grade ore. Water source. 5,000 tons probable, until [illegible] irrigation scheme.
[illegible]	Surkhana Valley Mid. Asia	[illegible] [illegible]	16-17 5-17	Open pit	Flotation & autoclaves	1,500	2,500	60,000	150,000	Permanent importance doubtful. 150,000 tons probable maximum.
[illegible]	[illegible] Crimea	[illegible] [illegible]	10.8 to 17.8	Open [illegible]	Flotation & [illegible]	1,000	2,500	[illegible]	[illegible]	May enter export [illegible]
[illegible]	[illegible]	[illegible]	5 to 30	[illegible]	[illegible]			[illegible]	[illegible]	Little importance
[illegible]	[illegible]	[illegible]	5 to [illegible]							Little importance
[illegible]	[illegible]	[illegible]	[illegible]							Little importance
[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	Little importance
[illegible]	[illegible]	[illegible]	[illegible]							Little importance
[illegible]	[illegible]	[illegible]	[illegible]							No importance
[illegible]	[illegible]	[illegible]	[illegible]							May be important in future
[illegible]	[illegible]	[illegible]	[illegible]							Little importance
						5,000	8,500	190,000	164,500 to 464,500	Annual total probable - [illegible],500 tons

Elementary Sulphur	Kerch	8,100	9,000
	Polovsk	2,000	2,000
	Kalata	7,500	15,000
	Krasnodar	-	500
Total Native, plus Elementary from Pyrites		25,500	31,000

a 1935 production estimated: Actual [illegible] may be less.

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CONSULTING ENGINEERS
NEW YORK CITY

TABLE II

[illegible] RESERVES [illegible] REGION

Metric Tons

DISTRICT	NON-CUPREOUS PYRITES A+B+C-1	% S	C-2	% S	TOTAL	CUPREOUS PYRITE A+B+C-1	C-2	% Cu	% S	TOTAL
Sectiarka	19,274,000	46.41	14,882,000	46.41	34,156,000	66,312,000	26,011,000	1.4	46.4	93,383,000
Kurdzhali	8,[illegible]00	44-46	1,331,000	36-45	4,023,000	[illegible]	3,316,000	[illegible]	[illegible]	11,376,000
San Stefano	2,49[illegible],000	42.0	1,278,000	42	3,777,000	[illegible]	[illegible]	[illegible]	[illegible]	2,016,000
Chelopech	[illegible] separate		Considerable			[illegible]	[illegible]	[illegible]	[illegible]	17,220,000
Plaiva	" "		Considerable			[illegible]	[illegible]	[illegible]	[illegible]	32,000,000
Madan	14,136,000	40	2,[illegible]7,000		14,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4,351,000
Krasno Polech	[illegible]f,000	40	1,[illegible],000		4,[illegible]	[illegible]	4,[illegible]	[illegible]	[illegible]	16,797,000
Rudozem	1,[illegible],000	47.77			1,[illegible],000		[illegible]	[illegible]	[illegible]	[illegible],000
Chelopech						1,868,000	682,000	2.1	40.0	2,550,000
TOTAL	42,274,000		21,[illegible],000		63,[illegible],000	116,[illegible],000	61,[illegible],000			170,334,700 b

a (All A+B+C-1)

b Notation [illegible] from concentration [illegible] indicated from [illegible] 47/48% as raw material for acid and elementary sulphur production

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TABLE III

RESERVES OF COPPER ORE IN OTHER DISTRICTS THAN URALS

DISTRICT	TOTAL TONS OF COPPER ORE RESERVE	PER CENT COPPER IN ORE	
Djezkazgan	192,000,000	1.67	Smelter planned
Balkash (Kounrad)	258,000,000	1.1	" "
Boshtchekul	318,000,000	0.8	
Spassko Uspensk	3,200,000	2.5	Smelter planned
Almalyk	201,000,000	1.1	" "
Siberia	18,500,000	1.85	
Zangezour	4,560,000	4.00	Smelter in operation to be increased
Agarak	104,000,000	0.6	
Allaverdi	2,600,000	2.0	Smelter in operation
Sadon	2,100,000	2.0	
Belokony Trumbon	1,760,000	3.0	
Kola Peninsula	4,400,000	0.5	
TOTAL	1,116,120,000		

Note: Above table shows basis of ore reserves on which smelters will be based. All smelters to be equipped to recover H_2SO_4 from fumes:- Soviet orders to this effect being very explicit, despite fact that concentrates from this remote southern and eastern porphyry copper ore will be very poor sulphur grade (20-25%). The Soviet Government views this acid production as warranted because of geographical locations and because there is little added cost in utilizing these fumes.

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PLANNED MINING, SMELTING, ACID AND ELEMENTARY SULPHUR PRODUCTION FOR URALS DISTRICT

ABLE IV ining District	I Annual Mine tonnage to Mill and Smelter	II Re-Floated Pyrite Tailings (48%S) tons	III Copper Concentrates	IV Elementary sulphur	V Refloated tailings for H_2SO_4	REMARKS
Degtiarka	4,500,000	2,557,000	409,000	580,000 1st plan or 80,000 2nd plan	1,047,000 or 2,349,000	Plans of elementary sulphur undecided. Considerable tonnage lump non-cupreous pyrite expected
Pishma	150,000	85,250	13,600		85,250	
Blaiva	1,350,000			250,000		600,000 tons H_2SO_4 planned from fumes.
San Donato	450,000	256,000	41,000		256,000	375,000 lump non-cupreous pyrite can be mined yearly in addition
Baimak	875,000	492,000	88,000		492,000	Considerable lump pyrite can be expected
Kalata	660,000	350,000	51,000	107,000		100,000 tons ore to smelter, fumes for H_2SO_4. 360,000 tons non-cupreous pyrite
Karabash	1,200,000	613,000	109,000		613,000	
Perm						No mines
Polevsk	60,000			20,000		
Krasno Uralsk	945,000	537,000	86,000	undecided	537,000	250,000 tons lump pyrite can be expected.
TOTALS	10,190,000	4,890,250	797,600	~~957,000~~ or ~~457,000~~	3,030,250 or 4,332,250	

Col. II Refloated Pyrite tailings for either Sulphuric Acid or elementary Sulphur
Col.III Tonnage of copper concentrates, Fumes from roasting to be utilized for Sulphuric Acid.
Col. IV Planned tonnage of elementary sulphur production.
Col. V Tonnage of re-floated tailings (48%S) remaining for H_2SO_4 after tonnage of tailings necessary for elementary sulphur have been deducted.

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ESTIMATE PROBABLE MINING, SMELTING, H_2SO_4 and RECENTRATE SULPHURIC ACID PRODUCTION PLANT EQUIPMENT

TABLE V	I Annual Mine tonnage to Mill and Smelter	II Re-Floated Pyrite Tailings (48%S) tons	III Copper Concentrates	IV Elementary sulphur tons[a]	V Refloated tailings for H_2SO_4	Production Comp non-ferrous pyrite
Degtiarka	1,500,000	852,500	136,000	30,000 or 327,000	644,500 or nothing	Considerable
Pishma	150,000	85,250	13,600		85,250	Very little
Blaiva	450,000			30,000		Considerable
San Donato	240,000	137,000	21,800		137,000	375,000
Baimak	570,000	325,000	52,000		325,000	Considerable
Kalata	360,000	102,500	23,600 conc. 100,000 ore to fce.	32,400		350,000
Karabash	970,000	496,000	86,200		496,000	Very little
Perm				[illegible]		No mines - receives from Krasno Uralsk and San Donato
Polevsk	60,000			[illegible]	[illegible]	
Krasno Uralsk	450,000	256,000	41,000	undecided	256,000	250,000 (from Spasso-Bernia-Chalchedonia and N-pyrite mines
TOTALS	4,750,000	2,314,250	376,200	242,400 489,400	1,943,750	

[a] To this estimated probable production of elementary sulphur may be added - after several years - a possible 45,000 tons from Karabugaz and indeterminate amounts from the Donbass and Moscow Basin coal pyrites. Except for Karabugaz (itself problematical) all Soviet elementary sulphur is dependent, of course, on the survival of the Ushkevich flash-roasting. It is probably evident from this Report that this, also, is problematical. For actual 1934-1935 production see Table I.

See footnote[a] for Table IV

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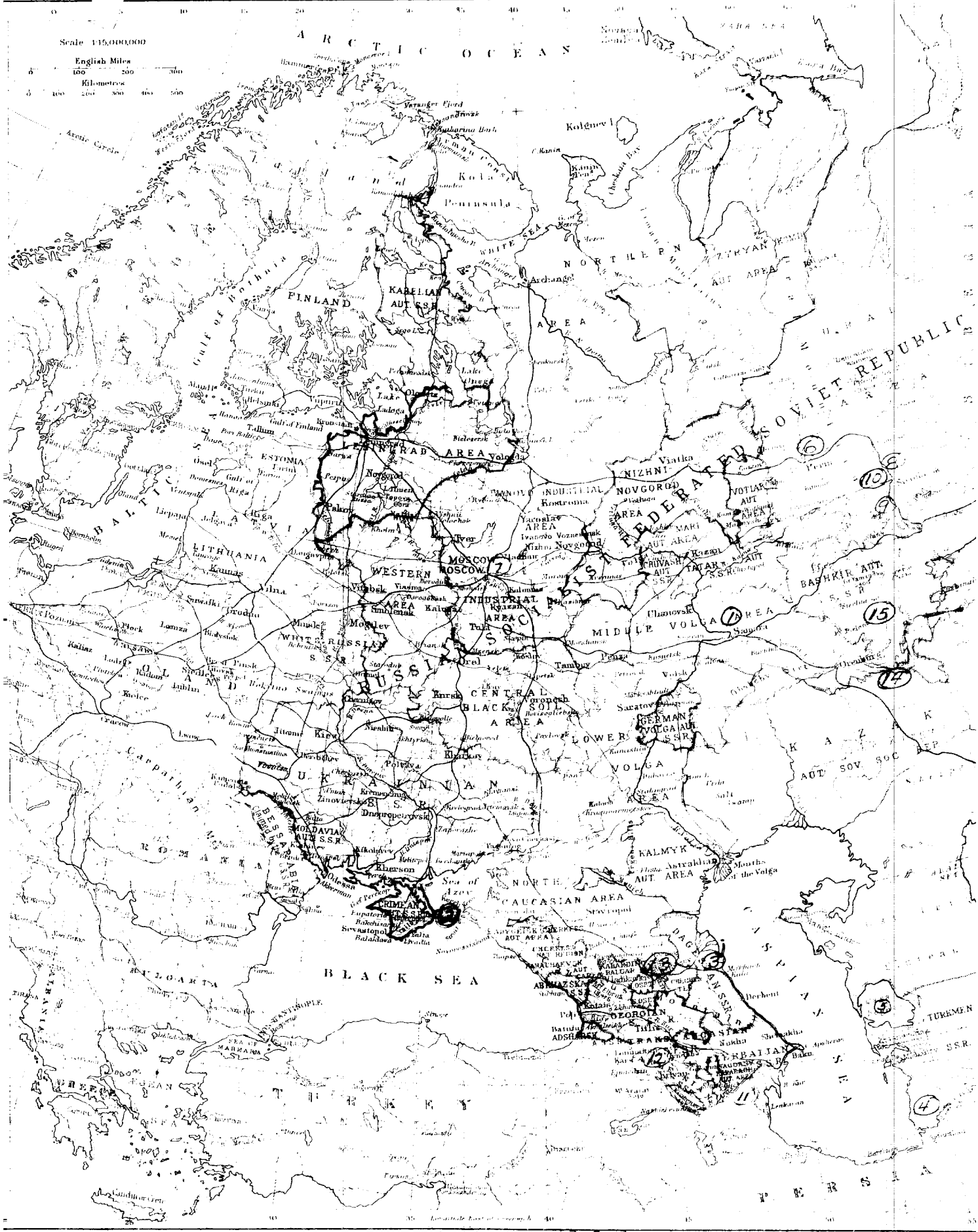
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Kola Peninsula
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NORTHERN TAYGA AREA
FINLAND
KARELIAN AUT. S.S.R.
Gulf of Bothnia
Lake Onega
Lake Ladoga
Gulf of Finland
ESTONIA
LENINGRAD AREA
BALTIC SEA
LATVIA
LITHUANIA
Kaunas
Vilna
Grodno
Lomza
Suwalki
Bialystok
Brest
Pinsk
Lida
Minsk
WESTERN INDUSTRIAL AREA
MOSCOW
MOSCOW INDUSTRIAL AREA
NIZHNI NOVGOROD
VOTIAK AUT. AREA
MARI AUT. AREA
CHUVASH AUT. S.S.R.
TATAR A.S.S.R.
BASHKIR AUT. S.S.R.
MIDDLE VOLGA AREA
Kuibyshev
Saratov
Penza
Tambov
Orel
Kursk
Voronezh
CENTRAL BLACK SOIL AREA
WHITE RUSSIAN S.S.R.
RUSSIAN S.F.S.R.
POLAND
Lwow
Kielce
Lublin
Kiev
Zhitomir
Poltava
Kharkov
Dnepropetrovsk
UKRAINIAN S.S.R.
Carpathian Mts.
RUMANIA
MOLDAVIAN AUT. S.S.R.
Kishinev
Odessa
Kherson
Sea of Azov
CRIMEAN S.S.R.
Simferopol
Sevastopol
BLACK SEA
BULGARIA
TURKEY
SEA OF MARMORA
CONSTANTINOPLE
LOWER VOLGA AREA
GERMAN VOLGA AUT. S.S.R.
Saratov
Stalingrad
Astrakhan
Mouths of the Volga
KALMYK AUT. AREA
NORTH CAUCASIAN AREA
Rostov
Taganrog
Novocherkassk
Krasnodar
Maikop
ABKHAZSK A.S.S.R.
GEORGIAN S.S.R.
Batum
Tiflis
Sukhumi
Kutais
ARMENIAN S.S.R.
Erivan
AZERBAIJAN S.S.R.
Baku
Kirovabad
Nukha
Derbent
DAGESTAN A.S.S.R.
Makhachkala
KAZAKH AUT. SOV. SOC. REP.
TURKMEN S.S.R.
CASPIAN SEA
PERSIA
Kolguev I.
Kanin Bay
Chesha Bay
Archangel
Vologda
Viatka
Perm
Kotelnich
Yaroslavl
Ivanovo Voznesensk
Nizhni Novgorod
Kazan
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Caucasian Area
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Georgian S.S.R.
Armenian S.S.R.
Azerbaijan S.S.R.
Abkhazsk A.S.S.R.
Crimean S.S.R.
Moldavian Aut. S.S.R.
Ukrainian S.S.R.
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Russian S.F.S.R.
Karelian Aut. S.S.R.
Bashkir Aut. S.S.R.
Tatar A.S.S.R.
Chuvash Aut. S.S.R.
Votiak Aut.
Mari Aut. Area
German Volga Aut. S.S.R.
Kalmyk Aut. Area
Kazakh Aut. Soc. Rep.
Turkmen S.S.R.
Caspian Sea
Black Sea
Sea of Azov
Gulf of Bothnia
Gulf of Finland
White Sea
Northern Taygan Aut. Area
Industrial Area
Central Black Soil Area
Middle Volga Area
Lower Volga Area
Leningrad Area
Western Industrial Area
Moscow Industrial Area
Yaroslavl Area
Ivanovo Voznesensk Area
Nizhni Novgorod Industrial Area
Smolensk Area
Kaluga Area
Tula Area
Ryazan Area
Kursk Area
Belgorod Area
Kharkov Area
Stalino Area
Voroshilovgrad Area
Taganrog Area
Rostov Area
Novocherkassk Area
Stavropol Area
Krasnodar Area
Maikop Area
Grozny Area
Makhachkala Area
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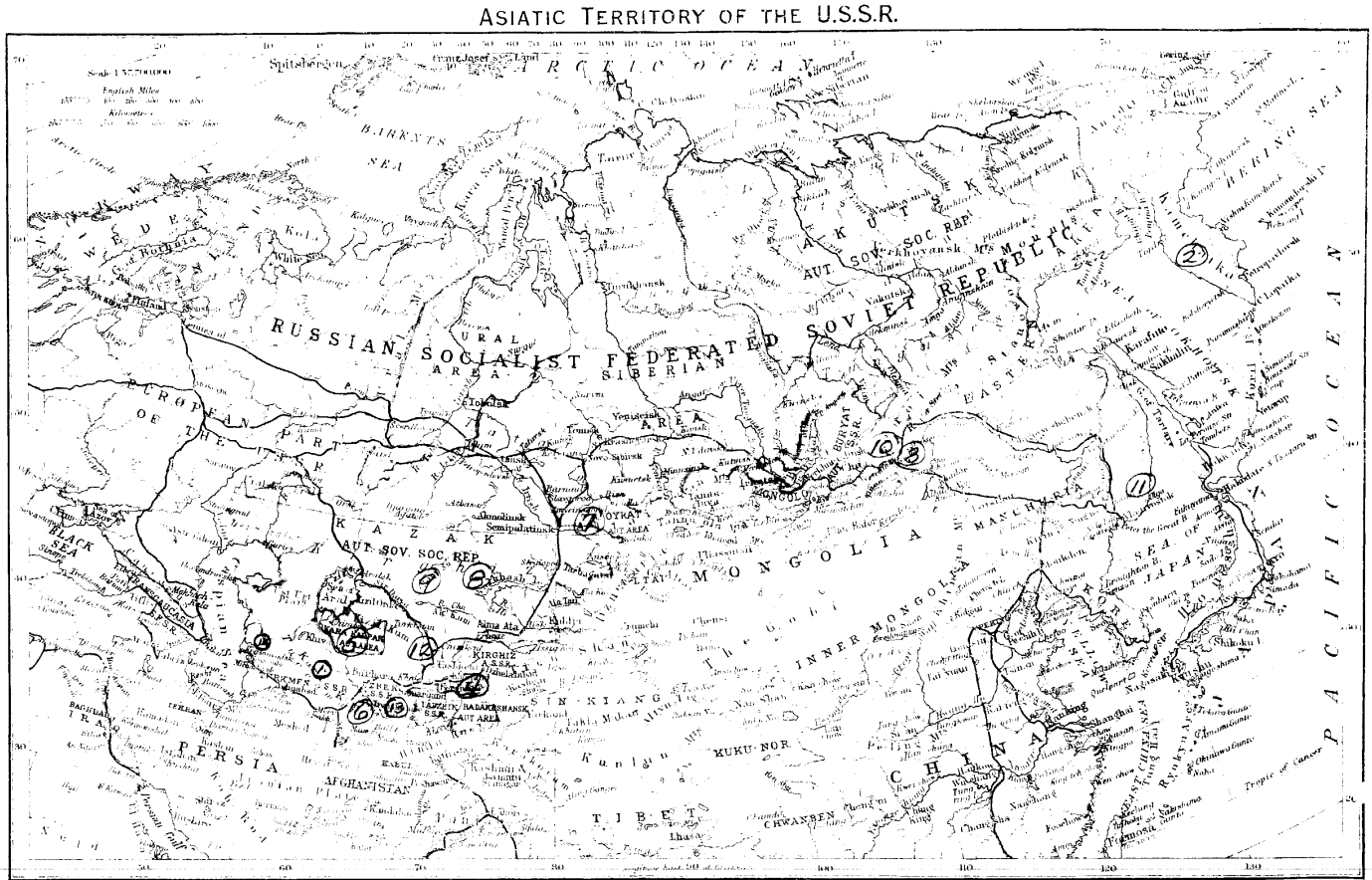

1. Kara Kum
2. Kamchatka
3. Transbaikal
4. Fergana
5. Godjinski
6. Gaurdak
7. Ridder Lead Zinc
8. Balkash Copper
9. Djezkazgan
10. Nerchinsk Lead Zinc
11. Tiutiho Lead Zinc
12. Chimkent Lead Zinc
13. Shirabad Baisunski
14. Karabugaz

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SECTION VI

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